THE CARD PLAYERS

Photographic Study from Life by Alfred Stieglitz

PHOTOGRAPHY

INDOORS AND OUT

A BOOK FOR AMATEURS

BY

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PREFACE.

Probably photography is to-day the most popular of hobbies. Indeed, the camera has come into such general favor that we may scarcely speak of photography any longer as a hobby, as a study or amusement delighting any special or limited class. Nowadays everybody takes photographs — who can get them; and sun drawings, after having been a great novelty, have taken their place among the pleasantly familiar things of every-day life.

A critical Englishman once said that he would like photography better if it were not for the pictures. The remark was doubtless intended as a rebuke to the people who, in their eagerness for the pictorial result, forget that photography is a science, and as a science requires careful study and a clear understanding of the optical and chemical laws upon which it has developed.

I will admit having seen photographs that made the Englishman's remark seem almost reasonable; but I do not count myself among those

who think that in photography the pictures are a secondary consideration. It is not by photography as an incident in the study of chemistry that my affections have been stolen, but by photography the mirror of nature, the handmaid of the artist. We all love pictures, and we can love them without hating optics or chemistry.

At the same time, it is to be remembered that optics and chemistry are photography's etymology and grammar, and this book is addressed particularly to those amateurs who, while they acquire their chief pleasure from the pictures as pictures, have sufficient respect for the study and a strong enough purpose toward good work to seek real knowledge of the elements of photography.

I have sought to convey this knowledge in every-day language. I shall frighten no one with $AlK(SO_4)_2.12H_2O$ when I mean alum. In the story of the earlier chapters I have endeavored to sketch the primary principles of photography. In the chapters following are hints which it is to be hoped the amateur may find to be a practical aid in his home gallery, in the field, and in the many artistic applications of modern photography.

Many readers of my photographic articles have asked, "What sort of a camera shall I get?" This puzzling question and others not so puzzling I have tried to answer in the right place. Within

space so limited it is possible only to sketch the chief and more familiar processes, and I make no apology for omitting much in the way of formulas, etc., which the beginner may wish to seek when he has ceased being a beginner.

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A. B.

BROOKLYN, Sept. 1, 1893.

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PHOTOGRAPHY INDOORS AND OUT.

CHAPTER I.

THE SUN TRIES TO SPEAK.

WHEN the first man, wandering in the wild garden of which he found himself to be the only human inhabitant, approached the brink of some quiet pool, and looking down, saw for the first time his own surprised face, how novel must have been his emotions! Adam had scanned all that nature cast about him. He had perhaps studied the wonder of his own form, the symmetry of his limbs, the grace and power of his hands. But now he saw his own eyes.

This first photograph must have been a sight upon which Adam gazed long and wonderingly. And can we not readily believe that this first subject of the sun's portrait-painting art — the first "sitter" in the gallery of nature — longed at some time to seize and carry away the pictures he saw in the water? Certainly the people who followed Adam continued for many years to wish that reflected images might be captured. But the

tantalizing visions, the traceries drawn life-size in the water, or glowing in miniature on the burnished surface of a shield, vanished and returned without human control.

The Chinese have a tradition that the sun has photographed a landscape on a frozen stream. Two hundred years ago the French writer Fénelon said in his fanciful story, "Une Voyage Supposé:" "There was no painter in that country; but if anybody wished to have the portrait of a friend, of a picture, a beautiful landscape, or of any other object, water was placed in great basins of gold or silver, and the object desired to be painted was placed in front of the water. After a while the water froze and became a glass mirror, on which an ineffaceable image remained."

The sun really began in Adam's time to tell his wonderful secret. Adam must have noticed that light browned his skin, if he did not understand the sun's habit of painting the leaves green or reddening the side of the apple. And when Adam's boy, straddling his father's knee, exclaimed, "Papa, I see myself in your eyes!" the riddle of the lens came very close to discovery.

Ancient men must have noticed another photographic principle. In the shadow of a tree the sunlight falling through a chink between the leaves does not make a bright spot of irregular outline like the opening through which it passes, but makes a circular image — a photograph of

the sun, in forming which the opening amid the leaves has, by focusing the rays of light, acted as a lens.

What people call the "romance of discovery" is, indeed, a tale of hairbreadth escapes. A principle like that of photography seems at scores of times on the point of discovery; and it is highly interesting to witness the manner in which wise men, helped by accident, but not helped enough or at the right time, do not discover it.

Light, the great first principle of photography, has piqued and excited scientific men from the very beginning. For a long time it was supposed that sight sent out something toward an object, as we reach out our hands to touch. We still use the expression, "darting a look." The fact that light carries the image to the eye was not quickly accepted, because light was long in being even slightly comprehended.

An understanding of the nature and properties of light is, in fact, almost as new as photography itself. Since it has been discovered that sight is, like hearing, a matter of physical touch — that we *feel* light and color as we do sound — wonderful advances have been made in this branch of science. By the aid of the spectrum the white light of day is split into various parts (just as the rainbow divided it before there was any science) and experiment has shown what property is owned by each color.

For instance, in the magical revelations of the prism — forming what is called the spectrum — it is seen that the three so-called primary colors (red, yellow, blue) produce certain vibrations in the rays of light in which they are carried, and that these color-laden rays produce certain corresponding vibrations in the eye, and, indeed, in the whole body, each color having an influence according to its own particular property. Thus red produces the sensation of heat; yellow produces the sensation of light in the nerves of the eye; while blue, without efficiency in producing light or heat, has the power to produce chemical changes in objects with which it comes in contact.

Naturally men first knew light by its illuminative power. Its heat could not have been long in making itself felt. The detection of the chemical action, much less an understanding of it, was a different matter. Men are only beginning to understand that now. Yet the earliest men, as I have suggested, must have noticed the tanning action of sunlight. The Greeks had seen the sun dull the opal and the amethyst, and the Roman philosopher Pliny watched sunlight bleach a piece of wax. Another Roman, Vitruvius, found sun rays so skillful in changing the color of paint, that he took care to place his pictures in rooms with a north light. But for many centuries nothing came of these observations. Nobody knew what they meant.

Meanwhile, long before men began to realize the meaning of this chemical action, certain optical facts became familiar. Globes of ice, or crystals found in the earth, probably suggested the use of mechanically contrived lenses. The Chinese philosopher Confucius, speaking of a glance into the future, has the phrase "as we use glass to examine objects." A piece of Assyrian glass in the British Museum, whether made for magnifying or for ornament, has the general form of a lens. It is over 2000 years old.

It is difficult to find much information of lenses in existence before the introduction of spectacles, which are supposed to have been invented by a Florentine monk about 1285, or perhaps by Roger Bacon shortly before that time. To Roger Bacon at least belongs the credit of giving a very early description of the principle of the telescope. But it was not until the children of a Dutch spectacle maker accidentally placed in position a concave and convex lens, that the telescope actually came into being, and made way for the many kinds of lenses which have since been devised.

Strangely enough light-pictures were first made without a lens. The sun-spot under the tree may have offered the hint; or some one carrying a lighted candle past a small opening in a darkened room — a keyhole, perhaps — may, by throwing the image of the flame, upside down, on the opposite wall, have shown to an observing

eye that a small aperture will collect and distribute rays of light. At all events, in the sixteenth century an Italian observer, Baptista Porta, constructed on this principle a complete camera obscura. Making a small hole in the shutter of a darkened room, Porta found projected on the wall, or white screen, opposite the opening, an inverted picture of the landscape without.

THE CAMERA OBSCURA.

In his book on "Natural Magic" Porta shows how great was his delight at the discovery he had made. Visitors in his "dark room" are astonished at the revelation. "Now," exclaimed Porta, "we can discover Nature's greatest secrets!"

When Porta placed a lens over the opening in his window the light image was, of course, much clearer; and when he had placed a mirror at such an angle as to divert the rays and turn the projected landscape right side up, the charm of the new discovery seemed to be complete. It became the fashion to have devices of this kind for the entertainment of visitors at country houses,

and to this day the camera obscura is a familiar institution in public parks and at the sea shore, where unsuspecting strollers are seen in miniature by curious patrons of Porta's invention.

A small dark box with a lens, and with a semi-transparent screen at the back, which was not long in being devised, was no different in principle from the dark room in which Porta had first seen the inverted image of a landscape, and the camera of to-day is practically the camera of Porta. Porta discovered the principle of the camera obscura. The principle of the camera itself was not so easily understood or so quickly applied.

CHAPTER II.

FIRST "PICTURES OF SILVER."

EVERY thoroughgoing romance of the middle ages introduced an alchemist or two. The very name brings up images of dusky chambers with mysterious phials and uncanny vapors. These wizard-like searchers, who kept aloof from other men, listening for the whisper of a secret that nature would tell to no one else, came near discovering a great many things.

The object for which all of these alchemists, at one time or another, searched with much patience, though with very little of what we would now call scientific method, was that ingredient, never seen but confidently hoped for, which should say presto! to the baser metals and turn them into gold. Like the other people who were peering about the earth for the Fountain of Perpetual Youth, the alchemists were disappointed in their particular search, but they stumbled upon many curious facts which otherwise would long have remained undiscovered.

One of these alchemists, Fabricius, tossed some salt into a solution of nitrate of silver. Instantly

he saw the contents of the vessel undergo a remarkable change. A white deposit, chloride of silver, was formed by this combination; and when the alchemist carried some of this "horn silver," as he called it, to a window, he was astonished to see it gradually discolor in the light.

Looking further into the matter, Fabricius, we are told, found that a surface coated with chloride of silver and placed behind a lens, was discolored in gradation according to the lines of light. Here, on the threshold of photography, Fabricius stopped.

At the point where the alchemist's science left off, a Frenchman's imagination began, prophesying photography in a daring way. It was about two hundred years after Fabricius' discovery that Tiphaine de la Roche printed a fanciful book, a grotesque kind of fairy story, in which the reader is carried (on a hurricane) among strange scenes and stranger people. One of the queer inhabitants of the region visited by the romancer tells how the genii artists produce pictures. "You know," says the queer inhabitant, "that rays of light reflected from different bodies form pictures, paint the image reflected on all polished surfaces — for example, on the retina of the eye, on water, and on glass. The spirits have sought to fix these fleeting images; they have made a subtle matter by means of which a picture is formed in the twinkling of an eye. They coat a piece of canvas with

this matter, and place it in front of the object to be taken. The first effect of this cloth is similar to that of the mirror, but by means of its viscous nature the prepared canvas, as is not the case with the mirror, retains a facsimile of the image. The mirror represents images faithfully, but retains none; our canvas reflects them no less faithfully, but retains them all. This impression of the image is instantaneous. The canvas is removed and deposited in a dark place. An hour later the impression is dry, and you have a picture the more precious in that no art can imitate its truthfulness."

Many of the early chemists seemed to have noticed the effects of light on compounds of silver. As long ago as 1727 J. H. Schulze tried the experiment of placing a piece of paper bearing black lettering over a surface covered with a mixture of chalk and nitrate of silver. The light, passing through the paper, blackened the silver coating save in the lines of lettering through which the light could not pass, thus leaving a white tracery on the otherwise blackened surface. Here was the principle of photography fully declared. Indeed, Schulze has been called the discoverer of photography, though much more remained to be discovered before photography could be applied.

An important step toward following up the little experiment of Schulze was made by a Swedish chemist named Scheele, an investigator of whom all

chemists speak with respect. It was Scheele who first undertook with anything like scientific care to watch the action of light on chloride of silver. His first discovery was that different colored rays of light had different effects upon the composition. Thus he discovered that the silver quickly discolored under the blue rays of light, while the compound was scarcely affected at all by red rays. Another chemist, Senebier, found that "in fifteen seconds the violet rays blackened silver chloride as much as red rays did in twenty minutes." Scheele's second discovery was that light decomposes silver chloride; but exactly what takes place in this decomposition the chemists have never yet been able to agree. Count Rumford did not agree with Scheele. He held that it was not light but heat that produced the chemical change. But the heat theory was soon overthrown by other experimenters. However, it is by no means certain that action upon the compounds of silver may not be affected by agencies other than light. In fact, experiment seems to show that an action similar to that produced by light, if not the same, may be produced by other forms of energy, such as electricity.

It might not be worth while to follow up each of these steps in the study of light and its action on the silver compounds if a knowledge of these principles was not so necessary to any proper understanding of what photography means. If we

do not understand something of the meaning of light we shall be in the dark as to the very foundation of photography.

The important point which Scheele's discovery began to emphasize is that photographic action is not performed by light as a mass, but (as I suggested in the foregoing chapter) by a certain element of light. The visible rays of light which have the greatest chemical effect upon a sensitive surface are the blue rays, the rays at the blue or violet end of the spectrum. But there are invisible rays beyond the violet, on the end of the spectrum opposite the red, which affect the photographic plate as greatly as the violet rays affect it, just as the invisible rays beyond the red have, as Sir William Herschel discovered, heat as great as the red, if not greater. Again we find that the rays giving the sensation of light to the eye are strongest in the region of pure yellow rays.

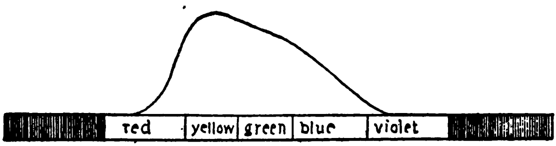


FIG. 1. ACTION OF VISUAL RAYS.

A diagram will make this clearer. In Fig. 1 we see a band illustrating the manner in which a prism splits up white light into its component parts. The line rising and falling illustrates the *visual* intensity of the spectrum colors; that is to

say, the strength of the colors in conveying the sensation of light to the eye. We see that the

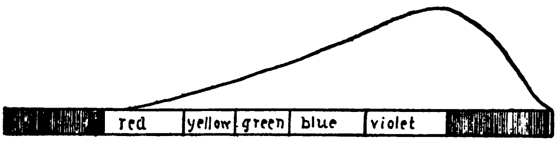


FIG. 2. ACTION OF PHOTOGRAPHIC RAYS.

strongest light rays are in the yellow section of the spectrum.

Now, if we look at Fig. 2 we shall see how different the photographic rays of light are from the visual rays. The line here shows the relative effect of the prism colors as they fall on a surface

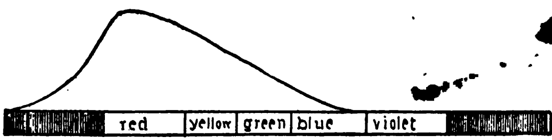


FIG. 3. ACTION OF HEAT RAYS.

covered with chloride of silver, and we discover that the rays having the greatest influence on the silver are those beginning in the blue and running through the violet into the invisible rays beyond. Yellow affects the silver much less, and red scarcely influences it at all.

In Fig. 3 we have a line showing in the same manner the relative quantity of heat and where it

is located among the different ingredients of white light. Whereas the strongest *photographic* action is in the violet rays and the rays beyond the violet, the strongest *heat* action is found in the red rays and the rays beyond the red. Roughly speaking, then, blue is the photographic color, yellow the illuminating color, and red the heat color.

The rays of light having that power of chemical action utilized in photography are called chemical or deoxidizing rays, but also, and particularly, *actinic* rays, and the quality possessed by these rays is called actinism. Thus it is with actinic light that photographers are always particularly concerned; but the student of photography is obliged to watch the effects produced by all kinds of light. The refusal of certain colors to impress themselves upon the ordinary photographic plate is an important matter for consideration, and must be kept in mind by the operator in photography, no matter how simple a form his photography may take.

But for a long time this question of color was not so important to those who were struggling to master the secret of sun-drawing as the matter of chemical action in general. Step by step advanced the discovery of silver's remarkable properties. Professor Charles, of Paris, the inventor of the hydrogen gas balloon, is said to have produced a rough kind of photograph by throwing

the shadow of a person's head on a sheet of white paper covered with a silver solution. The shadow part of the paper remained white, while the illuminated remainder darkened, leaving a white head in relief.

There are many indefinite accounts of experiments such as that attributed to Professor Charles, but the first experiments of which there is anything like a trustworthy record were made by the Englishman, Wedgwood.

Wedgwood was busy with his photographic experiments at the close of the last century. From what he says about red, yellow, and violet light it seems doubtful whether he knew anything of the discoveries of Scheele and others in this direction. However this may have been, he with great sagacity copied prints and paintings on glass by placing them over sheets of paper or white leather coated with nitrate of silver; and even went farther by placing his sensitive surface at the back of a camera obscura, where the lens might act upon it.

In the experiment with the camera Wedgwood was not successful. Sir Humphry Davy, who worked with Wedgwood in these inquiries, and who after Wedgwood's death published an account of their experiments, did succeed in securing impressions of small objects with the aid of the solar microscope, by using chloride of silver instead of nitrate of silver in coating the paper.

The industrious Wedgwood died without being

able to study one of his pictures in any light stronger than that of a candle, for the white light which made the print blackened the whole sheet when it was brought forth. What Wedgwood and Davy wanted, and what other experimenters long sought in vain, was something that would render the image on the paper a permanent image — that would destroy the sensibility of the surface after the image had been formed. It was plain to them all that silver not acted upon in forming the image must somehow be got rid of before the paper could be taken out of a dark place. Water would not remove it. "Nothing," wrote Davy, "but a method of preventing the unshaded parts of the delineations from being colored by exposure to the day is wanting to render this process as useful as it is elegant." But the experimenters were still where the prints required to be kept — in the dark.

CHAPTER III.

THE PATHFINDERS.

How was the sun's printed image to be "fixed"? This was the question.

The obstacle which Wedgwood and Davy encountered in their effort to make the photographic image "stay put," was the stumbling-block which for over thirty years lay in the path of those who tried to follow up the promise which the sun had repeatedly given. What could remove the silver that had not been darkened by the light, and thus prevent the total blackening of the sensitized sheet?

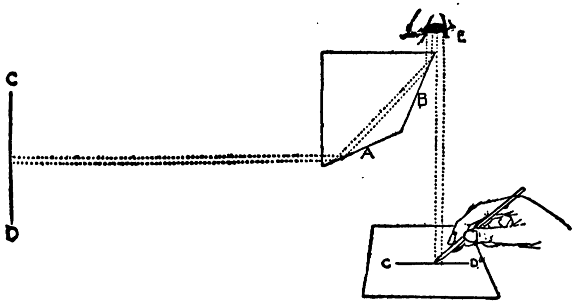
The man who solved this mystery was Henry Fox Talbot.

Talbot was an accomplished student. He had tried mathematics and politics (serving two years in Parliament), and after devoting considerable attention to the study of light, he turned with great zeal to photography.

It appears that Talbot conceived the idea of securing permanent impressions through the lens while sketching one day at Lake Como, in Italy. At that time, the camera lucida was frequently

used in sketching from nature, and Talbot was availing himself of the assistance offered by this instrument in making his sketches. Nowadays we should not ascribe much value to drawings made in this way, but before the appearance of photographs the results were considered interesting.

The principle of the camera lucida is similar to that of the camera obscura, the difference lying in the reflection of the image by means of mirrors placed at an angle in such a manner that the outline might be traced, as illustrated in the



THE PRINCIPLE OF THE CAMERA LUCIDA.

Object at C D is reflected through a prism on surfaces A B to eye at E. The eye then appears to see object on paper below, where the outlines are traced. The same effect is produced by the use of a mirror at an angle.

accompanying drawing. Struck by the beauty of the lake scenery, as minutely reflected under his eye, Talbot formed the notion of fixing the image upon some sensitive surface.

At this time, Talbot knew very little of what

had been done by Wedgwood and Davy. It was not until after he had begun similar experiments that he learned the particulars of Wedgwood's unsuccessful use of the camera obscura. At the outset, Talbot hoped to secure sun prints on paper spread with chloride of silver, and to hide the prints from the light in portfolios, from which they might be taken for inspection in candle-light. The first prints were of flowers and leaves, which made their impression in white on sensitized paper.

From these simple tests of the action of light on silver, Talbot pressed forward, step by step, until one day he succeeded, by an hour's exposure, in making a lens picture in his camera obscura. This was in 1835, and numerous pictures were made in the same way during that year.

Talbot's success in this and later experiments is explained by the fact that he managed to render his chloride of silver more sensitive to light than any of his predecessors had been able to make it. His process consisted in soaking his sheet of paper in a weak solution of common salt. One side of the paper was then brushed over with a weak nitrate of silver solution. Chloride of silver thus was formed on the surface of the paper, but the manner of forming it left a slight excess of silver, by which the surface of the paper was rendered so sensitive that only a short expos-

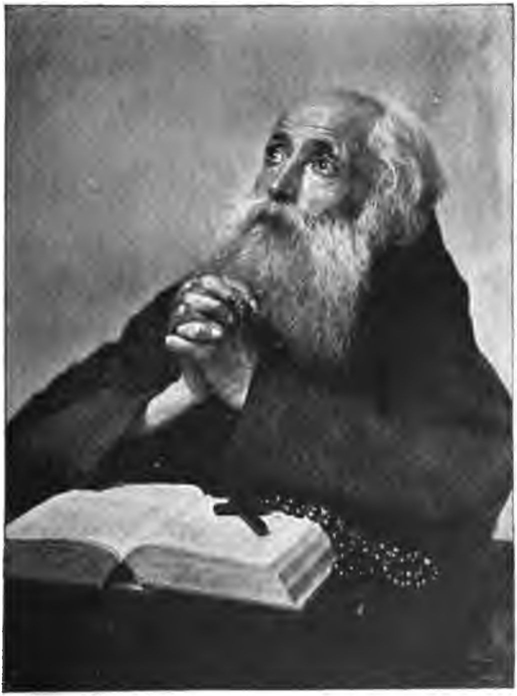
ure was necessary. A few moments only were necessary to darken it in the light.

But the great bugbear of "fixing" had yet to be conquered. After many trials, Talbot hit upon a successful method. When the printing had been completed, the paper was thoroughly washed, and then soaked in a solution of common salt, or in a solution of either iodide or bromide of potash. Emerging from such a bath, the print was found to have lost its sensibility, and the image might at last be safely examined in daylight.

Talbot might well be delighted with this discovery, for it bridged over a great chasm in photographic progress. Sun printing could now become a permanently useful process.

In the midst of the exultation following this discovery, and while Talbot was preparing to communicate the facts of his process to the world, the news came that a Frenchman had also succeeded in fixing the camera image. By what means the Frenchman had accomplished the feat no one in England could learn at the time.

Meanwhile, Prof. Faraday announced Talbot's discovery to the Royal Institution, giving to the process Talbot's name of "photogenic drawing," and exhibiting an interesting series of prints. A few days later (in January, 1839) Talbot himself read before the Royal Society a full description of his method. When Talbot's discoveries and the time of their announcement are taken into



THE FRIAR

From a Photograph by Horace Warren Gridley

account, we may see that it is not without some justice that he has been called "the Caxton of sun printing."

Let us now turn to France and look at the work of other pathfinders.

The little shop of Chevalier the optician, on the Quai de l'Horloge in Paris, was a popular resort early in this century for students and experimenters in various channels associated with optics. With each of these enthusiasts, however wild his scheme might be, Chevalier was willing to talk. But one class of enthusiasts rather taxed his patience — those tireless strugglers who sought to fix the image of the camera obscura.

Chevalier used to smile at the hopeful ardor with which one experimenter after another tried with lens, dark box, and sensitive surface to permanently imprison the pictures drawn by the sun.

One day — it was in the year 1825 — a pale, timid, shabbily-dressed young man came into the shop and asked the price of one of the new cameras then being sold.

Upon hearing the price the stranger gave signs of great disappointment. Chevalier ventured to ask the young man what use he wished to make of the camera.

"I have succeeded," replied the young man, "in fixing the image of the camera on paper. But I have only a rough apparatus, a deal box furnished with an object glass."

"Here," thought Chevalier, "is another of those poor fools who want to fix the camera image," but added aloud: "I know several men of science who are working for that result, but as yet they have not succeeded. Have you been more fortunate?"

The stranger — as Chevalier's story goes — pulled out an old pocket-book, and revealed a slip of paper bearing an image that truly astonished the optician, for it was a clearly defined view of Paris, obviously made with a camera.

"How did you do this?" demanded Chevalier.

The young man exhibited a little bottle of liquid, which he gave to Chevalier with instructions which he said would enable the optician to obtain like results. Then the gloomy stranger went away, and Chevalier never saw him again nor learned who he was. As for the liquid and the instructions, Chevalier tried both but could do nothing with them, possibly because he did not prepare the paper in the proper way, or missed some link that made the chain of operation complete. Yet the optician never ceased to believe that he had seen one of the men who first mastered the great secret of photography.

Among the occasional visitors at Chevalier's shop was Joseph Nicéphore Nièpce, who was, as we shall see, a man of exceptional qualities of mind. Nièpce was born at Chalons-sur-Saone, in 1765. He received a good education, and would

have entered the ministry but for the outbreak of the French Revolution. He served for some time in the Republican army, until ill health forced him to retire. Settling down at Chalons, he busied himself with scientific matters. Aided by his brother Claude he brought out a machine called the pyrelophore, for propelling vessels by aid of hot air, and also invented a species of bicycle. He afterward turned his attention to the vexed question of sun printing.

Nièpce's first attempts were along the lines suggested by lithography. He discovered that bitumen, a substance then called "Jew's pitch," refuses to dissolve after it has been acted upon by light. Of this trait in bitumen he at once took advantage. Dissolving bitumen in oil of lavender, he spread a thin layer upon a smooth lithographic stone. The drawing he wished to copy was then varnished, a process increasing the transparency of the paper, and laid upon the prepared stone. After an exposure in sunlight it was taken off. Wherever black lines appeared in the drawing the bitumen beneath remained untouched by the light, and when oil of lavender was poured upon the surface of the stone, these lines dissolved, leaving the light-touched parts hard and fixed. The acid afterward applied would eat into the stone along the lines thus left free from bitumen. Metal plates proved better than stone, and Nièpce's "heliography" was established as a new art.

Nièpce took some of his bitumen pictures to England, and would have liked to exhibit them before the Royal Society, but being unwilling at that time, before carrying his experiments farther, to tell how his pictures were made, the society refused to consider the discovery.

Probably Nièpce had secured the first permanent photograph ever made, but naturally he longed to make pictures directly from nature, and to this end turned his attention to the camera obscura. His first camera was made from a cigar box into which the lenses of a solar microscope had been fixed. Here again, after trying various other substances, Nièpce made use of bitumen. The inventor himself gives this graphic account of his work: —

"The discovery which I have made, and to which I give the name of heliography, consists in producing spontaneously, by the action of light, with gradations of tints from black to white, the images received by the camera obscura. Light acts chemically upon bodies. It is absorbed; it combines with them, and communicates to them new properties. Thus it augments the natural consistency of some of these bodies; it solidifies them even; and renders them more or less insoluble, according to the duration or intensity of its action. The substance which has succeeded best with me is asphaltum dissolved in oil of lavender. A tablet of plated silver is to be highly polished,

on which a thin coating of the varnish is to be applied with a light roll of soft skin. The plate when dry may be immediately submitted to the action of light in the focus of the camera. But even after having been thus exposed a length of time sufficient for receiving the impressions of external objects, nothing is apparent to show that these impressions exist. The forms of the future picture still remain invisible. The next operation, then, is to disengage the shrouded imagery, and this is accomplished by a solvent, consisting of one part by volume of essential oil of lavender and ten of oil of white petroleum. Into this liquid the exposed tablet is plunged, and the operator, observing it by reflected light, begins to perceive the images of the objects to which it had been exposed gradually unfolding their forms. The plate is then lifted out, allowed to drain, and well washed with water."

The inventor goes on to say: "It was, however, to be desired that, by blackening the metal plate, we could obtain all the gradations of tone from black to white. The substance which I now employ for this purpose is iodine, which possesses the property of evaporating at the ordinary temperature."

Thus the bare plate represented the shadows in the picture, and Nièpce used iodine to blacken the metal and increase the contrast between the plate surface and the patches of asphaltum. But with

all the devices he had employed, Nièpce could scarcely produce a picture in full and natural relief. There were other difficulties. So long a time — eight hours or more — was required to photograph a landscape that the form of the shadows at the time the lens was uncovered was greatly different from the shape they assumed before the exposure was at an end, and it may readily be imagined that there could be little relief or truthfulness of effect. And then, the bitumen being hardened only on the upper surface, the development and washing often dissolved the lower layers and damaged the image.

Nièpce's struggles and successes were, in a general way, known to Chevalier, who one day described them, so far as he then could, to another frequenter of his little shop. The man to whom he gave an account of Nièpce's products had been in the habit of dropping in at least once a week to talk with Chevalier. His name was Daguerre, and at the time when Chevalier mentioned the name of Nièpce, Daguerre was in a state of great enthusiasm over some surprising discoveries of his own.

CHAPTER IV.

THE TRIALS AND TRIUMPHS OF DAGUERRE.

Daguerre was a scene painter. He had received his art training in the studio of Dagotti, who had "created" some of the most brilliant pictures seen on the stage of the Grand Opera at Paris. Daguerre was a quick pupil, and when he began painting on his own account it soon became plain that he would excel his master.

He was not content with the ordinary methods of scene painting. By painting on both sides of the canvas, and lighting first one side and then the other, he produced effects then entirely new, such as those of sunset and moonrise, volcanic fire, lightning, and so on through various devices. He was not only of an artistic and inventive disposition, but of a gay temper as well; and the story goes that he frequently joined in stage dances for love of the merriment, in the midst of scenery of his own painting.

Daguerre delighted Paris one summer by opening a diorama. On vast rolls of canvas he painted with great care and finish a variety of scenes which, by the use of changing illumination

and other means, were made to change in a manner very mystifying to most observers. Street scenes passed from day to night, lights twinkling in the windows. In his landscapes volcanoes blazed and villages were shattered by earthquakes.

In preparing his preliminary drawings for these outdoor scenes, Daguerre frequently made use of the camera obscura and the camera lucida, and like so many others before him he soon began to wish there was some way of compelling the reflected pictures to remain where the sun placed them. He had heard of experiments with sensitized surfaces, but he had no knowledge of chemistry. He had not as yet even the privilege of beginning where others had left off, for he did not know what others had accomplished, and in that day it was no easy matter to find out.

Beginning at the beginning, however, Daguerre secured a suitable camera from Chevalier and set to work. No one need be told how many disappointments fill up the life of such an experimenter. Scores, hundreds of searchers for the photographic secret had been frightened off by the seemingly insurmountable difficulties of the process after it had advanced to the point where the image first appears.

Daguerre differed greatly from any other well-known worker in this field. In the first place he had no scientific prejudices. He did not see half so many difficulties as did the great scientists to

whom chemistry was perfectly familiar. In the second place he was not merely playing with experiment. He was intensely interested in succeeding. He was determined to capture the image of the camera and simply refused to fail.

Eager to secure all the light possible from experiments that had already been made, Daguerre's first step, after hearing from Chevalier about Nièpce, was to write to Chalons. Nièpce was inclined to distrust people who inquired into his experiments, and his feeling on receiving Daguerre's letter was indicated by his exclamation, "Here 's another of those Parisians who wish to pump me!" But when he came to Paris, on his way from England, he hunted up Daguerre, and the result was that the two men formed a partnership, each agreeing to communicate to the other all he had discovered or might discover, and each to share in the profit and glory of the general result—should there happen to be any of either.

Upon first hearing from Daguerre, Nièpce had been certain, and said so, that Daguerre was much further advanced than himself. This may have been true as to Daguerre's ideas, but his actual results were less available than the results which Nièpce had reached. This was readily seen when the two men, after much diffidence on the part of Nièpce, came to explain their discoveries to each other.

After signing an agreement with Nièpce,

Daguerre returned from Chalons in a state of mind not altogether pleasant. Triumph did not seem much nearer than before. Yet it seemed incredible that Nièpce and himself should, after going so far, fail to conquer that phantom which, like some fragile butterfly, was always mangled in the capturing.

Daguerre shut himself up in his laboratory. If the secret he sought was anywhere in chemistry he was bound to have it. He buried himself in books. For nearly two years he lived in the midst of ponderous scientific volumes, bottles, retorts, and melting pots. No one, not even Mme. Daguerre, was ever permitted to enter the dark chamber in which the scene painter was fighting out his fight with chemistry. Nièpce died, without finding success. Daguerre still pursued his labors without a halt. Everything was neglected for the laboratory.

Poor Mme. Daguerre became frightened at her husband's habits. Perhaps, she thought, he has gone mad. She consulted physicians as to the possibility of insanity. She asked scientific men if they really thought the object of her husband's search was not a crazy dream, a sort of will-o'-the-wisp, never actually to be laid hold upon. The scientific men shook their heads, and Mme. Daguerre contented herself with their cautious judgment that what her husband sought was "not absolutely impossible."

Taking a hint from Nièpce's method, Daguerre tried bitumen, but found, as Nièpce had found, that this substance could not be trusted to produce with any certainty a good photographic image. Following up the use of metal plates coated with silver, Daguerre made new experiments. Nièpce had used iodine to darken the plates. Daguerre exposed the silver-coated plate to the vapor of iodine and made "iodized silver plates," which received an impression with two or three hours' exposure. But the image was of poor quality. Even a well-lighted object produced but a faint impression.

An accident revealed to Daguerre the advantage of combining silver and iodine; another accident revealed to him a better means of developing the plates than any he or Nièpce had been able to find by their direct experiment.

In the course of his experiments he one day removed from his camera a plate which failed to show any traces of an image. Regretting the insufficient exposure (as he then considered it), Daguerre put away the plate in a cupboard until such time as he might clear it off for further use.

On going to the cupboard the next morning, he found a clearly defined image on the surface of the plate.

Here was a mystery!

Daguerre gave a short exposure to another plate and placed it in the cupboard beside the

first. Again an image appeared. Some chemical fumes in the closet were bringing out the images on the plates.

But which? This could only be discovered by trying separately each chemical substance in the cupboard. And after carefully following this plan the experimenter found that the image was brought out by the fumes from some uncovered mercury in a saucer.

Daguerre was a happy man that day. When we recall the years of toil he had given up to this unpromising search, we can understand the nervous excitement in which he watched the action of the different chemicals in that cupboard and the delight with which at last he discovered the potency of the modest mercury.

He soon found that an exposed plate held over a dish of warm mercury developed rapidly. Fully as important was the discovery — which Talbot, unknown to Daguerre, had already made with regard to impressions on paper — that the image could be fixed by immersion in a solution of salt and water, which cleared off the iodide of silver upon which light had not acted.

Isidore Nièpce succeeded his father in the partnership with Daguerre. When the time came for an announcement of the discovery, Daguerre and Nièpce sought to form a commercial company with which to bring the invention before the people. A subscription was opened in 1838. But

the public was skeptical about the discovery, and it may well have seemed to Daguerre that after all his struggling there was little reward. The idea of starting a company had to be entirely abandoned. Daguerre then betook himself to the astronomer Arago.

When Arago saw Daguerre's pictures he was amazed. The thing upon which scientists had wasted so much speculation was at last a reality and appeared before his eyes. Daguerre's written account of the discovery explained the process in all its details.

Arago made public announcement of the discovery. Daguerre soon found himself famous. The vague account of the new method of picture-making excited the liveliest curiosity. The Home Minister in the French Government induced the legislature to pass a bill giving Daguerre a life pension of 6000 francs a year, and 4000 francs a year to Nièpce, that the discovery might be given free to France and to the world. Few governments have acted with such prompt generosity; for though the pension was not large, its intention and effect were very gratifying to Daguerre.

This was in June. On August 10 an immense crowd filled the hall and approaches to the Academy of Science, where Arago was to describe the discovery. Artists, scientists, and a scattering of public men of many professions pressed

forward to hear the secret of the camera's image. After fourteen years of struggling Daguerre was a hero. In his enthusiasm over the minute perfection of the camera's drawing, Paul Delaroche exclaimed, "Painting is dead from this day!"

CHAPTER V.

SEEKING EASIER PATHS.

PARIS soon became much excited over the "daguerreotype." The shop of Chevalier was overrun with people in search of cameras and outfits, and glistening lenses began to peer from windows and roof cornices in various parts of the city.

Most people had a much exaggerated idea of what Daguerre's discoveries meant. They looked to see the colors of nature, as visible in the mirror, impressed upon the plate. There was great disappointment over the difficulty of securing any image at all. Daguerre's formulas, like a good many other formulas which have since appeared, seemed simple and explicit enough. Few realized without experiment what nice care and continued patience were required to secure anything like a satisfactory picture.

I shall not stop to give any particular description of the daguerreotype, or of the many difficulties of producing it. Nor shall I undertake to tell the reader of the various improvements that Daguerre and others succeeded in devising for

this sort of picture-making. Picture-making on Daguerre's plan is now practically obsolete, and I wish in this preliminary story of photography to dwell in detail only on those matters that will help the photographic beginner of to-day to understand what modern photography is and how it came to be what it is.

With all the improvements upon the daguerreotype that were made in Daguerre's time, — many French and English experimenters helping forward the work, — the dainty picture on metal remained very imperfect.

Up to this time no one had taken a photographic portrait. Daguerre himself, a scenic artist, had always been interested in the reproduction of natural scenery, and probably had thought very little about portraiture. However this may have been, it is a fact that the first daguerreotype portraits were made on this side of the Atlantic.

Professor Morse, famous as the inventor of the electric telegraph, was in Paris at the time Daguerre's discovery was announced. Morse was then bringing his own inventions before the world. Before returning to the United States he became acquainted with Daguerre, and soon resolved to introduce the daguerreotype in this country. It so happened that Professor John Draper and Professor Morse made the first camera pictures of the human face.

The poor sitter of 1848 had a thrilling experience. His face was powdered that it might be more actinic in color, and the sooner impress itself upon the plate. Then he was compelled to sit in the glare of the sun for twenty or thirty minutes. He was allowed to close his eyes, but even then the strain of a fixed position and the glare of the sun imposed a severe strain on the victim of the new science. Draper ingeniously made use of a large tank filled with ammonio-sulphate of copper, through which blue liquid the sunlight passed, and lost in the passage the heating rays so distressing to the sitter.

The increased sensitiveness of the plate under fresh discoveries soon made it possible to shorten the imprisonment of the sitter's head, yet even then the length of the exposure was a prolonged ordeal in comparison with the modern mode of photography.

A French writer, speaking of the early days of portraiture in Paris, gives this picture of the operation: "The model took a graceful attitude, resting one hand on the back of a chair, looking as amiable as possible. But the sun fell full in his eyes! The operator gives the final warning to keep perfectly still! The seconds pass, succeed each other, and seem to expand into centuries; the sitter, in spite of all his efforts, is overpowered by the solar rays; his eyelids open and close, his face contracts, the immobility to which

he is constrained becomes a torture. His features shrivel up, tears fall from his eyes, perspiration beads on his forehead, he pants for breath, his entire body shakes like that of an epileptic who wishes to keep still, and the daguerreotype plate represents the image of a poor wretch undergoing all the tortures of the ordeal by fire." A sense of relief comes with the writer's assurance that "shortly afterward the discovery of the accelerating substances permitted daguerreotype portraits to be taken with something of artistic feeling."

Daguerreotypes became more popular in the United States than in any other country, not excepting France itself, and many an old family cabinet reveals portrait treasures, whose delicate fidelity to life may well inspire a grateful acknowledgment to Daguerre and his ardent followers.

There is a daguerreotypist in Nathaniel Hawthorne's "House of the Seven Gables." In one chapter of this remarkable romance the heroine makes a criticism upon daguerreotypes which we may agree, after the scene described by the French writer I have quoted, was probably not without justification. "I don't much like pictures of that sort," says Phœbe, "they are so hard and stern; besides dodging away from the eye and trying to escape altogether. They are conscious of looking very unamiable, I suppose, and therefore hate to be seen."

CHILDHOOD

From a Hand Camera Photograph by William Schmid

"If you would permit me," says the artist, looking at Phœbe, "I would like to try whether the daguerreotype can bring out disagreeable traits on a perfectly amiable face. But there certainly is truth in what you have said. Most of my likenesses do look unamiable; but the very sufficient reason, I fancy, is because the originals are so. There is a wonderful insight in heaven's broad and simple sunshine. While we give it credit only for depicting the merest surface, it actually brings out the secret character with a truth that no painter would ever venture upon, even could he detect it. There is at least no flattery in my humble line of art."

Daguerre died in July, 1851, after having rendered a great service to the world. The daguerreotype, as he left it, was not destined to live much longer than its inventor.

Beautiful as the daguerreotype picture was in many ways, it had a serious defect beyond any that have been mentioned — it did not permit of duplication. Made on a copper plate, it had not the transparency which would have made sun-copying possible. This was the great deficiency in the daguerreotype process. The same may be said of all processes that have worked on an untransparent surface.

Thus photographers have worked from the hint given them by Talbot rather than from the hints offered by Nièpce and Daguerre, notwithstanding

the great value of the chemical discoveries made by the two Frenchmen.

Talbot, who had fixed the image of the camera years before Daguerre's discovery was announced, produced a translucent negative from which any number of duplicates could be made. In this *negative* the lights and shadows were reversed, so that when the sun passed through to the sensitive surface beneath a *positive* was formed — an image following the lights and shadows of nature. The positive which was directly produced by Daguerre's process was necessary in a sun image which was not to be used as a means of printing but was itself the print.

Sun pictures became so popular after the publication of Daguerre's discoveries that Talbot found every inducement to follow up his own discoveries. Up to the time when he read his paper before the Royal Society this British worker had been in ignorance of a most important fact: the fact that a sufficient impression had been made upon his sensitive paper long before the image could be seen; in other words that light soon produced, as on Daguerre's plate, a *latent* though invisible image which only required to be "developed." To develop the latent image Talbot used a solution of gallic acid and nitrate of silver, which brought the image into clear relief. This discovery, which was in the line of Daguerre's discovery with the mercury, so greatly affected the time required to pro-

duce an impression, that photographs which had occupied an hour's time in the exposure could now be made within thirty seconds.

The value of the gallic acid had been noticed by others. Wedgwood discovered that salts of silver darkened more rapidly when spread on leather, which contained acid qualities of the same nature. Then an English clergyman, the Rev. J. B. Reade, made some beautiful light impressions on white kid gloves. The story goes that the scientific value of the experiment was scarcely appreciated by the owner of the gloves, who was Mr. Reade's wife; and the property contained in the gloves being due to the nutgall used in tanning, the discoverer found it desirable to use the gallic element on other surfaces, and was successful.

Talbot was much delighted to find that he could make leaf impressions on his calotype paper even in moonlight. The calotype prints were used as negatives in printing on the ordinary photogenic paper which Talbot had first invented.

One of the immediate results of Talbot's new process was the making of portraits upon paper sensitized on the calotype principle. Some of these portraits, made before the daguerreotype had been successfully adapted to portraiture in England, were sent over to Paris and seem to have been much admired in that city. Talbot himself went to Paris in 1843. Large audiences

heard him describe his method of making pictures on paper, and of copying them by the aid of sunlight. A year later Talbot began publishing a book called "The Pencil of Nature," in whose six parts numerous photographic illustrations were published. These illustrations are now much faded. Talbot had not yet learned, what every photographer is now taught, that all traces of the "hypo" (which he adopted for fixing) must be thoroughly washed out before the print is dried.

By making use of the bromine introduced by Goddard, Talbot's process was further improved, and in 1851 the industrious inventor introduced an instantaneous method, which he illustrated at the Royal Institute by photographing a piece of a newspaper fastened on a rapidly revolving disk in a single flash of light from an electric battery. In the resulting negative every letter is said to have been clearly defined. If this experiment is correctly reported, no more remarkable feat has ever been accomplished.

Had photography gone no further than Daguerre carried it, had it never become more exact and delicate than one of Talbot's calotypes, it might still have been a very useful science, and the world would have found thousands of ways of using and delighting in its products. Yet it was at this stage imperfect in many respects, and much restricted in its usefulness as well as in its beauties.

The defects of Daguerre's process have already been mentioned. Talbot's negatives, being made on paper, were subject to all the blemishes that existed in paper manufactured at that time. Then paper was much more difficult to handle, both in the camera holder and in the developing, than a piece of metal. Another difficulty arose from the fact that the positive print, having to be made by means of the sunlight's passage through the negative, the paper on which the negative was formed must not be thick. At best, the paper had so little translucency that printing was a slow process. Some French experimenters were shrewd enough to wax the paper, and thus render it much more favorable to the passage of light.

Although the first portraits in England were made on Talbot's paper negatives, daguerreotypes became most popular for portraiture after a time. The daguerreotype certainly gave a very delicate and nicely modeled image. For other purposes, however, Talbot's process was more satisfactory, and amateurs, whose enthusiasm over photography led them into various kinds of artistic adventure, liked the paper print better than the positive on metal. The paper print, without a brilliant and distressing gloss, was always more admirable to the artist. And so the two forms of photography each had admirers.

Meanwhile, everybody who recognized the importance of photography, who realized what it

might do and what it had already begun to do for art and science, was on the alert for better methods of producing the photographic image.

Sir John Herschel, who had given a valuable hint about the use of hyposulphite of soda in "fixing," came forward with the suggestion that the sensitive salts of silver should be placed upon glass instead of upon paper. The advantage of transparent glass over half-transparent paper was seen at once, but for some time no successful pictures were made upon glass.

Herschel put a glass plate at the bottom of a dish containing chloride of silver in water. After the silver salt had settled evenly on the surface of the plate the liquid was siphoned off and the plate dried. But only a faint image could be produced on a plate prepared in this way.

No one then fully understood that the silver solution will not darken on its own account. It must be in contact with some foreign matter. The photographer sets his glass jar of nitrate of silver in the sun to "clear" the liquid. If the liquid could be darkened by light when free from contact with foreign substances, the contents of the jar would soon darken. But let the operator in pouring the liquid from one dish to another get a spattering upon his nose! Into what a beautiful brown will the sun turn those tenacious stains!

A Frenchman took the glass plate and solved the problem by coating the glass with albumen

before putting on the nitrate of silver. The originator of this important improvement upon the suggestion of the ingenious Herschel was Nièpce de St. Victor, a nephew of Nicéphore de Nièpce. Beating up white of egg with iodide of potassium, bromide of potassium and common salt, St. Victor poured the mixture on a plate of glass, thus forming a fine film. When the dried plate was dipped in nitrate of silver, iodide and bromide of silver were formed in the albumen. To develop the plate after exposure, gallic acid was used. St. Victor did not succeed so well with this process as did two other Frenchmen, Blanquart Evard and Le Gray, who acted upon his suggestion.

CHAPTER VI.

THE WET PLATE.

PHOTOGRAPHY took one of its greatest leaps when Frederick Scott-Archer, an English sculptor, introduced what is called the "collodion process."

Several important discoveries had led up to this remarkable invention by Scott-Archer. In the first place the distinguished Swiss chemist Schönhein (in 1846), by soaking ordinary cotton in a mixture of nitric and sulphuric acids, produced the explosive substance insoluble pyroxyline, which soon received the name of gun-cotton. With less of the acids a soluble pyroxyline was produced.

At this stage an American, Maynard of Boston, appeared with a discovery of the highest interest. Maynard found that when pyroxyline was dissolved in ether and alcohol a creamy liquid of singular qualities was produced. To this liquid Maynard gave the name of collodion. The great value of collodion lay in this, — that when it was poured upon a piece of glass the evaporation of the liquid left a strong skin upon the surface.

Maynard was not thinking of photography when he made his experiments with collodion.

Indeed, the surgeons had used it for covering skin bruises and lacerations before the photographers thought of adopting it as a basis for their silver. It was Le Gray, who had waxed the calotype paper and improved the albumen process of St. Victor, who suggested that collodion might be useful in coating the photographic plate. Other experimenters agreed with Le Gray, and many of them tried it; but the first to actually practice collodion photography and bring it to perfection was Scott-Archer.

Scott-Archer had been drawn into photographic experiment by his wish to secure photographic copies of his sculptured work, and it was while he was busy in his first attempts that Maynard discovered collodion.

Here is a brief outline of this first collodion process as the inventor himself described it: Immerse eighty grains of cotton-wool in a mixture of one ounce each of nitric and sulphuric acids; take out after fifteen seconds and wash thoroughly in running water; dissolve the pyroxyline so obtained in a mixture of equal parts of sulphuric ether and absolute alcohol. The solution so obtained is ordinary collodion. Add some soluble iodide — usually iodide of potassium — to the collodion. A little potassium bromide may also be added. Pour the iodized collodion on a perfectly clean glass plate, and allow two or three minutes for the film to set. Take the coated

plate into the dark room and immerse it in a bath of silver nitrate (thirty grains to every ounce of water) for about a minute. Here a chemical action takes place by which silver iodide is formed in the pores of the collodion. Remove the plate, which is now sensitive to white light, place it in a holder, and expose it in the camera.

The development is accomplished by pouring on a mixture of water, one ounce; acetic acid, one dram; pyrogallol, three grains. The fixing was first in the hyposulphite of soda. The cyanide of potassium afterward used is an exceedingly dangerous poison.

As might be expected, the announcement of Scott-Archer's collodion method caused a great stir. The character of the image produced on the collodion-coated plate was more beautiful than anything yet effected in any negative-making process. As delicate as the finest daguerreotype image, the collodion negative gave opportunity for any number of positive prints, and the clearness of those parts of the plate representing the shadow of the picture made it possible to print with great rapidity. In a short time the collodion plate of Scott-Archer had banished the calotype of Talbot and its great rival, the metal plate of Daguerre.

With the success of the collodion process amateur photography fairly began. From the earliest days of photography there had been experimenters

who practiced picture-making for love of the work itself, and with no idea of commercial interests; but the number was small in comparison with the army of enthusiasts that found a fascination in the "wet-plate" process.

The word "amateur" is often very confusing. It is well understood that the word, derived from the Latin *amator*, lover, is meant to designate a person who follows any pursuit for love of it, as distinguished from a person who makes the pursuit his means of livelihood. Everybody understands the meaning of "professional" or "mercantile" as applied to a photographer who has a public gallery and business quarters, and of "amateur" as applied to photographers whose interest in picture-making is merely incidental, for personal amusement. But when we come to speak of a great photographic investigator who gives much thought to the study of the science, and yet does not make pictures for a living, we become conscious of something awkward, of something not quite right in the word "amateur."

Yet it will not do to say that the word "amateur" means a mere dabbler. There is no reason why a person who follows photography for the love of it should not acquire as much knowledge of the science as a person who practices it for purely mercantile reasons. In fact, as we have seen and shall see further on, the photographers who have made a trade of photograph-making

have seldom been the photographers who have made the great discoveries and inventions. In this respect photography is perhaps different from many other sciences and many other arts; and so, in spite of the dissatisfaction we are sometimes forced to feel over the word "amateur," we shall be obliged, until some one invents better terms, to speak of amateur and professional in distinguishing between the two classes of workers.

The early amateurs who undertook photography by the wet-plate process had to face labors and disappointments over which the modern amateur would become very impatient, if he were not frightened off altogether. The apparatus required for photographing out of doors was, from the modern point of view, in the best of cases very clumsy. Collodion, silver bath, and developer had to be carried to the spot, or very close to the spot, where the picture was to be taken, for an exposure must be made before the silver coating of the plate advanced too far toward drying. Yet the enthusiasts traveled miles with their outfits, sometimes carrying tanks of water into mountain heights where water was not likely to be found.

A friend has described to me the circumstances under which he once saw a photographer in a western town photograph the interior of a church. The church was several streets away from the gallery, but the photographer, who was an elderly

man, and anything but nimble, undertook to carry his prepared plate from the gallery to his camera rather than go to the trouble of carrying or setting up the necessary apparatus in or near the church. The camera was duly focused, and the old photographer, after silvering the plate in his gallery "dark-room," started for the church on a gentle trot, which increased in energy as the fear of being a trifle late seized upon the operator. The picture of the old man, nervously running with the plate-holder under his arm, and of his running back again after the exposure, was indelibly photographed on my friend's memory; and after enjoying the novelty of the sight, the spectator was glad that the hurried plate, as he afterward learned, performed its work successfully.

The fact that photography became so popular after the introduction of the collodion process naturally increased the zeal of the experimenters. The process was more satisfactory than any that had gone before it: it produced a delicate and perfect image, and permitted unlimited copying; and it is still practiced, — a photographic method of very great usefulness. But there were many obstacles in the way of good work, many difficulties and annoyances, especially to the amateur who worked with insufficient room and materials. The collodion was found to be difficult to prepare and disagreeable in odor. The preparation and coating of

the glass plates had to be done with the greatest nicety. The silver bath was so fitful and changeable, and altogether so erratic in its conduct, that people who were superstitious on no other subject came to believe that there was some bewitchment in the solution. All this was very "mussy," and black finger-stains from the silver made it difficult for amateur or professional to avoid advertising his habits.

One of the first experiments with the collodion process was the changing of the negative into a positive without printing. This was done by whitening the silver deposit on the plate, and backing up the glass with a piece of dark velvet or a coat of black varnish. Almost every old family cabinet contains examples of portraits made in this way. They somewhat resemble daguerreotypes, though made in so different a manner.

Another kind of wet-plate positive was invented in the United States — a natural image on a surface of japanned iron. These have been known as ferrotypes, but the familiar, if inaccurate, name is "tintypes." They have had a remarkable popularity. The "tintype" wagon has traveled through many lands, though most frequently seen in our own. The sitting, the developing, and the mounting (generally in a paper frame) all occupy but a few minutes, and the product is so cheap that the poorest of people are able to own family portraits. Ferrotypes are still made by the

thousand at the city galleries, at the seaside, at the country fairs, and in the village through which the itinerant photographer makes his summer journeys. The young man with a loud voice, who stands at the door "drumming" trade with a handful of samples, is a familiar American "type."

For years the ferrotype remained a form of wet-plate photography. Recently the amateur has been interested in taking up the "dry" ferrotype process. With prepared plates and a simple method of development, dainty little pictures are quickly finished.

But positive processes of this kind — processes in which the camera is made to form the final image instead of a negative image, from which copies are made — have never had the artistic relief of the printing processes; and they have always had, and must always have, the disadvantage of presenting a reversed image, — everything is turned wrong side about, which does not make much difference in some cases, but makes a great deal of difference in others.

The special drawback of the collodion process being the necessity of using the plate soon after it was dipped in the silver, experimenters for a long time sought to overcome this difficulty by preparing a plate that might be used with equal success after it had dried. A "moist process" published in 1854 gave a method of keeping the surface of a plate damp, and preventing the crystallization

of the silver for a number of days. After being prepared in the usual way, the plate was immersed in a solution of nitrate of zinc and nitrate of silver and then drained. Another experimenter tried a solution of honey to coat the sensitized plate. This was called the "honey process." Various other methods, like that of submerging the plates in water till wanted for use, were tried from time to time, but there seemed to be no comfortable way of avoiding the difficulties of the wet plate without making plates that were altogether dry.

A French scientist, Dr. Taupenot, introduced one of the first dry-plate processes. Dr. Taupenot sensitized the plate in the ordinary manner; washed it, flowed it with albumen, dried it, dipped it again in a silver bath acidified with acetic acid, washed it and dried it again, after which it remained ready for use for weeks and months. But this was a complicated method, even after it had been somewhat modified.

To keep the silver from crystallizing in the process of drying, a curious variety of measures was tried. Among the "preservatives," as the different substances used in protecting the silver from the action of the atmosphere were called, were sugar, syrup, vinegar, gum arabic, beer, malt, tea, morphine, and tobacco. Nearly all of these ingredients, however they might accomplish their main purpose, made the plate slower in action.

A MIDSHIPMITE

From a Photograph by Alexander Black

It frequently had occurred to experimenters that instead of adding the silver to the coating of the plate, the silver might be made a part of the coating. After a time much experiment was turned in the direction of mixing together the silver and the coating, thus making an "emulsion."

Here, as in so many other cases, good theories were put forward by men who were not able to carry out the schemes or able to instruct others in a successful method of doing so. Thus a London photographer named Bellini said he had found a process for coating glass with a solution of shellac containing iodide, bromide and lactate of silver. "All that is necessary," he said, "is to coat the plate with this preparation and expose it in the camera." But it was found that in spite of the assurance so confidently offered something else *was* necessary.

Much more valuable than any suggestions that had yet been made were those offered by two Liverpool men, J. B. Tayce and W. B. Bolton, who added bromide of silver to the collodion, and flowed the parts with tannin before the drying.

A prominent American experimenter, Carey Lea of Philadelphia, added a few drops of *aqua regia* to the emulsion, and step by step the problem of the dry plate was solved. Bolton, for instance, washed the emulsion *before* coating the glass, by causing the evaporation of the ether and alcohol in a shallow dish, cutting up the matter

remaining, and washing out all the soluble salts, redissolving with alcohol and ether, and thus producing an emulsion ready at any time to be used in coating plates. All of these processes received the paradoxical name of "dry wet-plate" processes, and Bolton's method is still used for some of the finest forms of photographic work.

In time gelatine began to succeed collodion as a substance for retaining the silver salts on the plate. This was another of the long steps forward.

Gelatine is an animal substance of much usefulness. It is often obtained from the hoofs and horns of oxen, from bones, etc. It dissolves in hot water, and in cooling forms a jelly. In a pure state it is colorless and transparent. Glue gives gelatine in an impure form. For various reasons it is of great value as a substance in which silver may be held.

A Belgian chemist, Stas, showed the value of heat in increasing the after-sensitiveness of emulsion; but it was not until 1878, four years after the chemist's announcement, that a great stir was made in the photographic world by the announcement in London of Bennett's success in "stewing" the sensitive compound.

Bennett's discovery was that emulsion, kept in a bottle which was placed in hot water, increased in sensitiveness in proportion to the length of time it was allowed to cook. The emulsion was

kept in this hot-water bath for from two to seven days, after which it was carefully washed, flowed with equal care upon plates accurately leveled, and then dried — all this, of course, away from white light.

Bennett's triumph was followed by other triumphs, with the result that the same sensitiveness produced in the emulsion by long cooking was effected by boiling for a short time at a high temperature. Captain Abney, Dr. von Monckhoven and other investigators made ingenious advance in discovery and invention; and the highly sensitive dry plate, so long looked for, was a realized fact.

CHAPTER VII.

THE CAMERA IN MODERN PHOTOGRAPHY.

WE cannot yet call any photography ancient or even mediæval. What is half a century in the progress of science? But we may call modern that description of photography which has been practiced since the introduction of the dry plate.

Amateur photography, which had been widely practiced in the "wet-plate" days, became after 1880 a universal hobby. With plates that received an impression, even in a poor light, in a fraction of a second, that might be kept for months before exposure, and for months again before development, nothing seemed easier than photography. The "easiness" was an illusion; but photography flourished, was carried into thousands of homes, and the fraternity of enthusiastic students grows larger every year. The census tables show some curious figures in the growth of photography as a trade, but it might be truly surprising could some census reveal the increase in the number of amateur photographers between 1883 and 1893.

When photography began to be domesticated in

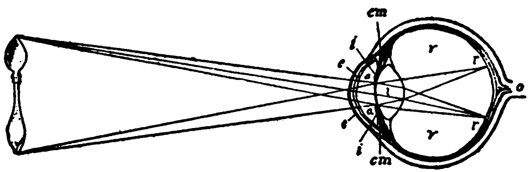
this way, much attention was directed toward new and better forms of camera. Nièpce had begun with a cigar box. From this small beginning the camera grew into a complex instrument. This growth was regulated, not merely by the size of the plate and the field of operations, but also and especially by the power of the lens. And this brings us to that highly important feature of photographic operation, not yet touched upon here, that first and foremost object of mechanical interest — the lens itself.

THE LENS.

It will be interesting, before looking at the different lenses which ingenious men have invented, to think for a moment of those remarkable lenses which have been given us by nature — the lenses in our eyes.

The eye is, indeed, a complete little camera. It has its lens, its dark chamber, its focusing mechanism, yes, and its sensitive plate. The accompanying sketch will suggest how much a camera is like the eye. The curved transparent membrane called the cornea is marked *c c*. Behind this is the fluid called aqueous humor, marked *a a*. After passing through these, the rays of light strike the lens *l*, which is protected by the ring of the iris indicated as *i i*. The iris surrounds the central dark spot of the eye. This dark spot is thus really a hole which is larger or smaller as the iris

expands or contracts. When there is much light the iris contracts. When there is less it expands



THE CAMERA OF THE HUMAN EYE.

again and is relaxed in the dark. The iris acts precisely as the "stop" or diaphragm is made to act in a camera. The ciliary muscles, marked *cm cm*, focus the eye for seeing at a long or a short distance. Passing through the lens, the rays of light are directed through the vitreous humor (*v v*) to the sensitive retina at *r r*.

The great naturalist Darwin once said that in considering the development of different species from the lowest forms of life nothing was more difficult to explain than the eye. The organ of sight is, we are all willing to admit, a wonderful thing, and yet we shall have to grumble at it a little, for it is, mechanically considered, far from perfect, in the best of us. At the very beginning it is a little distressing to learn that the human eye is in many respects a less perfect machine than the eye of many of the brutes.

All eyes, however, have certain defects. One of these defects is called astigmatism, and is caused

by the fact that the horizontal and the vertical curvatures of the ball do not always come into focus at the same time, for the reason that the curvatures are not precisely the same in every case. In fact, very few eyes are without some astigmatism. What astigmatism means, will be indicated by the study of this diagram (Fig. 4).

Show these lines to half a dozen persons, and ask each whether all the spaces seem of the same

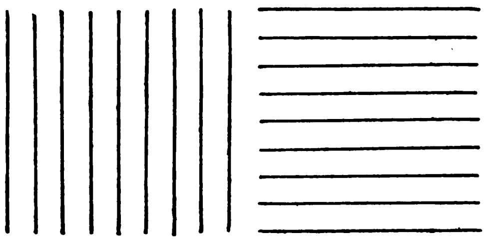


FIG. 4.

width, and all the lines equally defined. To many people (unless they are wearing spectacles devised to correct the error of sight), the vertical lines of one position will seem wider apart than the lines running horizontally. Others again will find the horizontal lines wider apart and more distinct. But by turning the page the special distinctness will, to a person whose eyes are affected by astigmatism, seem to move from one set of lines to another, showing that the eye is deceived.

This one defect of the eye is accompanied by

others more or less pronounced in different people, and entirely aside from the "far" and "near" sighted defects.

At the same time, while a lens carefully made, of good glass, is clearer and more accurate than the eye in its report of things reflected upon it, we have a right to expect of a lens that it shall report objects in such a way that the result may resemble images as the eye sees them. But we cannot get a perfect resemblance of images as the eyes see them until we use two lenses corresponding to our two eyes. One lens will show us an object only as one eye will see it. Two lenses side by side are used to give that effect of "looking around the corner" of things which is produced by our having two eyes, each, in a way, having an independent point of view. Everybody who has looked at stereoscopic pictures through the little instrument called the stereoscope, will realize the difference brought about by the use of two lenses.

The story goes that the children of a Dutch spectacle-maker, playing with lenses in their father's work-room, accidentally discovered the principle of the telescope by looking through two disks at a distant object. The simple principle used in the early telescopes was gradually expanded and developed. After photography came, lens-making naturally excited a great deal of interest, and remarkable improvements were made.

The various forms of single lenses are shown in this diagram: —

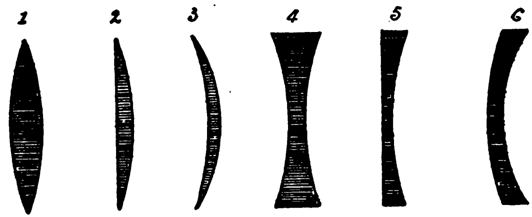


FIG. 5.

These forms receive the following names, — 1, double convex; 2, plano-convex; 3, concavo-convex; 4, double concave; 5, plano-concave; 6, meniscus.

Beginning with these primary forms, lenses are made up into complicated combinations, each combination having definite qualities. In order to understand why these groupings become necessary, let us examine the action of a simple convex lens. (Fig. 6.)

Taking the lines A, B, C, D, and E to represent parallel rays of light striking the lens LL, we discover that the outer rays A–C do not focus with B, and that the rays D and E, between the outer and the inner rays, focus with neither A and C nor with B. The deflected rays form two focal points (FF). In case the rays D and E entered the lens at an angle such as is represented in Fig. 7, the confusion of focus would

increase. This defect in the single lens is called *spherical aberration.* The defect is very largely

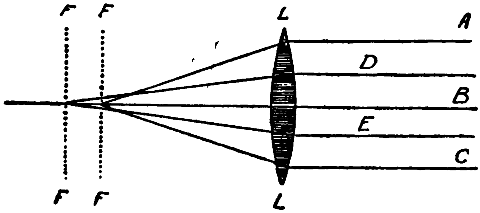


Fig. 6.

overcome by the use of a diaphragm or disk, which is placed in front of the lens and which admits rays only at points nearer the centre of the lens. Another kind of aberration interferes

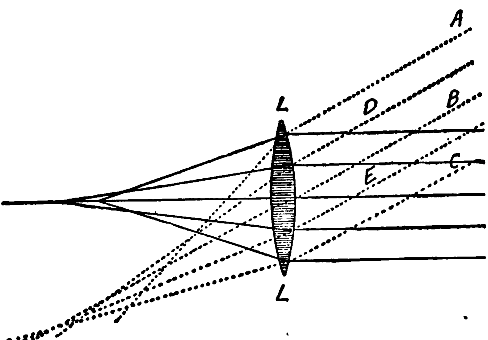


Fig. 7.

with the perfect action of this species of lens. This is called *chromatic aberration*, and is produced by the fact that the visual and chemical rays — of which I have spoken in the comments on light — do not coincide.

To completely correct these two kinds of aberration lenses require "correction" by the combining of different forms of glass and different kinds of glass. Lenses are made of two kinds of glass — crown glass and flint glass. When the two kinds of glass are combined, one corrects the chromatic aberrations of the other; and by the combination of concave and convex forms in lenses, the spherical aberrations are, so far as possible, accurately corrected.

These principles have been worked out with great ingenuity, and step by step, until the modern lens sometimes becomes a complicated mechanism with many layers of glass. For instance, the plano-concave was added to the double convex

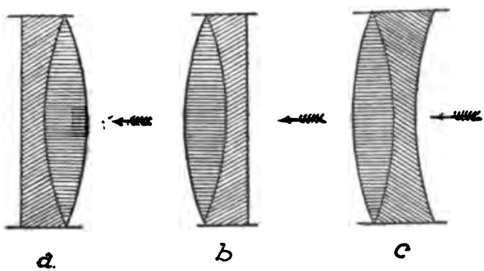


Fig. 8.

Arrows show direction of light rays entering lens.

so as to produce a lens like *a* in Fig. 8. Then the plano-concave was placed in front, so that the flat surface received the rays of light. And still better definition was afterward secured by pla-

cing the double concave in front of the double convex, as in *c*. The lenses thus united became

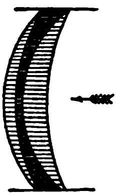


Fig. 9.

practically one lens, and were called single lenses. Various other forms of single lenses have since been made, sometimes with three elements, as in Fig. 9, which shows a meniscus flint lens cemented between two crown concavo-convex lenses.

After a time it was discovered that a separated combination of lenses had powers greatly superior to those of the single lenses. Two of these combinations are shown in Fig. 10.

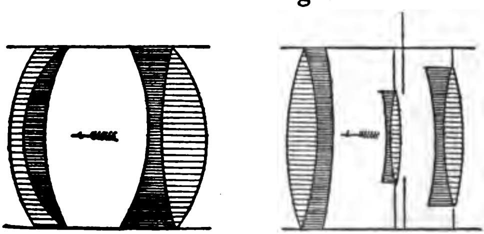


Fig. 10.

The first of these is the orthoscopic lens, devised to correct *linear distortion*, or the bending of lines on the outer edge of an image produced by a spectacle glass, or other simple lens, and to cure the *spherical aberration* in focus. There are four lenses in combination, a diaphragm resting between the two front and two back lenses. The second shows Dallmeyer's "triple achromatic" lens, with six lenses in combination, the

diaphragm coming between the first and second pair. Sometimes it has been found advantageous to employ very thick lenses, as in the Steinheil aplanatic lens, shown in Fig. 11.

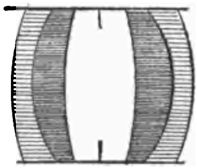


FIG. 11.

Designs for lenses are constantly undergoing changes, as practice and experiment reveal the usefulness of new combinations. One of the most useful of recent inventions is a telophotographic lens, designed for photographing objects at a distance. Dallmeyer, the inventor of the new lens, says: "Hitherto only two methods of producing large images had been employed: first, the use of very long-focus positive ordinary lenses; and second, the production of a primary image by one positive lens, and placing a secondary magnifier or second positive lens behind the plane of the primary image, which enlarges it more or less, according to its focal length and its adjustment between the positions of the planes of the primary image and that of the focusing screen, as in the photo-heliograph, etc.

"The first of the older methods had been seldom employed, except in astronomical photography, on account of its unwieldly dimensions; and the second method referred to is practically useless for ordinary photographic work on account of the great loss of light involved, rendering the

length of time necessary for proper exposure so great as to cause it to be almost prohibitive, except in the case of inanimate objects."

Of course any telescope may be arranged so as to place its image on a camera ground glass through an intervening lens. One operator mentions the use of the barrel of an opera glass, with the large lens toward the object.

In the Dallmeyer lens, the outer glass image is intercepted by an actinically corrected negative lens of greater negative power than the positive power of the other. How great the enlargement shall be, is determined by the distance apart of the lenses and the distance of the focusing screen.

THE FOCUS OF A LENS.

PRINCIPAL FOCUS. This term is applied to the point at which rays parallel to the principal axis of a convergent lens meet on the other side of the lens. Rays not parallel converge at a second point; and the relation between the two points is described as *conjugate foci*. (Figs. 6 and 7).

EQUIVALENT FOCUS. The equivalent focus of a lens is discovered by measuring from a point midway between the two combinations of a doublet lens, as from the diaphragm slot, and the ground glass when some object at a distance (300 feet or more) is in focus.

FOCAL LENGTH. The focal length of a lens is represented by the distance of the principal focus

from its optical centre. The optical centre is often described as at the point where the stop is placed; but this is inaccurate. The actual optical centre of a combination lens can only be determined by a calculation based on the centre of the *conjugate foci*, and it is probably unnecessary to go into so scientific a matter here. The equivalent focus is sufficiently discovered by measuring from the mechanical centre. Finding the centre of a single lens is thus described: Draw two parallel radial lines, one from the centre of each curvature, and both being oblique to the axis; then connect the points at which they touch the curved surface by a line which, in the case of a meniscus, must be prolonged till it meets the axis. The point at which this junction line touches the axis is the optical centre.

DEPTH OF FOCUS. Depth of focus, so called, in a lens, a property increased by the decrease in the size of the stop-opening, is the capacity to define objects at various distances with approximate sharpness. Thus portrait lenses have very little depth of focus, and certain small hand camera lenses have a great deal, giving approximate sharpness to all objects beyond a few feet from the lens.

STOPS AND DIAPHRAGMS.

The perforated metal plate placed in contact with a lens is called a "stop;" when not in

contact with the lens, but at some distance from it, the plate is called a "diaphragm." But both are often called stops. To "stop down" is to decrease the aperture through which the image shall pass, by using a diaphragm.

Simple single lenses cannot be used without a stop, and the perforated plate is fastened in place. Doublet lenses are accompanied by a series of diaphragms. In a symmetrical lens of this class the diaphragm is placed to greatest advantage midway between the two combinations. There is much difference of opinion as to how large should be the opening in fixed stops, and much also as to the position of diaphragm and "exposer" combinations.

A large opening is preferred for bold artistic effects. A small opening increases the working area of the lens; that is to say, the lens will work "sharply" over a wider area in proportion as the size of the opening is reduced. The size of the opening is regulated by the amount of light, by the speed at which the exposure may or must be made, and by the requirements of the subject and picture to be produced.

Diagrams generally are, and always should be, marked with some sign of their focal value. Mr. E. J. Wall gives this brief illustration of the system of marking, by which f/x expresses the focal length of the lens:—

"To find this number divide the focal length

of the lens by the diameter of the diaphragm; *e. g.*, focal length of lens, $8\frac{1}{2}$ in.; diameter of diaphragm, $\frac{3}{4}$ in.; $8\frac{1}{2} \div \frac{3}{4} = 11.3$; number of diaphragm, $f/11.3$. The Photographic Society of Great Britain, however, number the diaphragms in rather a different way, taking $f/4$ as the standard, which they call No. 1. This system is termed the uniform standard, or 'U. S. No.,' and the U. S. number for any diaphragm marked on the f/x system may be found by the following rule: Divide the focal length of lens by diameter of diaphragm to f/x, square the result, divide by sixteen, and the result will be the U. S. number. Example: Find U. S. number of diaphragm marked $f/11.3$. $11.3 \times 11.3 = 127.69$; $127.69 \div 16 = 7.98$, or practically 8, U. S. number."

Thus No. 1 is always one fourth of the equivalent focus of the lens; and under the arrangement of the numbers No. 2 will require an exposure twice as long as with No. 1, and No. 4 (the next number), twice as long as with No. 2, and so on. When the relation between the size of the stop and the length of the focus is the same, all lenses are, generally speaking, equally rapid.

The iris diaphragm is the name given to a form of diaphragm which, by the use of a series of metal or rubber plates, opens and closes like the iris of the human eye.

THE CAMERA BOX.

The camera box is very much the same to-day as it was in the early days of photography. It has changed considerably in the details of its make-up, but its general character is the same as when it was used by Daguerre. The lens is set in one end, the plate is held at the other. An important advance was made when the back of the box was adjusted so to be set at an angle different from the plane of the lens. This "swing back," as it is generally called, enables the operator to accommodate the surface of the plate to the laws of perspective in vertical and parallel lines, and to the correction of focus and distortion in foregrounds, in seated figures, etc.

Other improvements on the primary form of the camera were the rising and falling front board, bringing the lens opposite any line on the plate, and thus facilitating the placing of horizon lines, etc.; the swinging box, giving the vertical or horizontal form to the picture; a toothed wheel roadbed to aid in a rapid and convenient adjustment of the focus; a folding roadbed for the bellows carriage, and various other devices for making the camera compact, "handy," and of as little weight as is consistent with requisite strength.

When quick photography became possible, the cap which was used to cover the face of the lens was superseded by the "shutter" or exposer, a

piece of mechanism operated by a lever at first and afterward by an air tube. Hundreds of these exposers have been invented. The simplest form is the "drop shutter," shown in Fig. 12, in which a release permits a rubber band, or the weight of the shutter itself, to draw one opening across the face of another, the exposure occurring during the moment when the light flashes through the two openings. The drawing shows, in A, the back of the apparatus, the circular hole in the main part fitting over the tube of the lens. An end section of this main part is shown in C. Into this slides B, with a wide strip at the top, as shown in the side view, D, to prevent it from dropping all the way through. A small metal elbow (cutting of zinc or brass) sets into the notch at E when the shutter is set. The rubber band

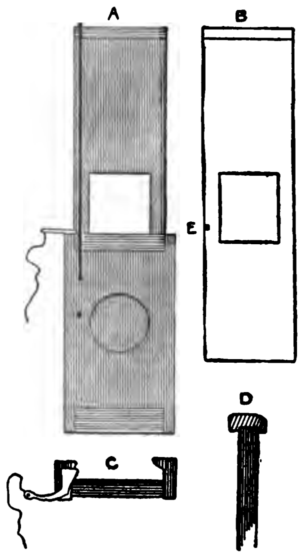


Fig. 12.

as shown in A may be stretched to either of two buttons at the back of the main part, to vary the speed, or may be taken off altogether for a mod-

erate exposure of about one fifth of a second. The speed may be greatly decreased by turning the apparatus so that the drop shall be at an angle. Of course the string must not be pulled violently, so as to make the camera oscillate. This sort of a home-made shutter is sometimes amplified by a pneumatic — air tube — attachment, which releases the catch that in the simpler form is drawn out by a string. The chief advantage of the tube over the string is that it does away with the chance of jarring the instrument. The pneumatic tube is used in almost all of the later exposers.

Among the forms of exposer which have recently been perfected are several which, by an arrangement of metal or hard-rubber disks, open in the centre and show a circular opening to any desired size, and contract again until the aperture is entirely closed. These operate instantaneously or slowly, as the operator may require. Admirable as these shutters are, they have the defect of giving the greatest amount of exposure at the centre of the lens, and thus increase the difficulty resulting from the lens's tendency to act most quickly in the centre. The ideal exposer would seem to be one that began to open at the rim of the lens and finally opened to the centre, closing again from the centre outward; but how the mechanical difficulty of constructing such a shutter is to be overcome, no one, I think, has yet been able to suggest.

An interesting result of the development of quick photography was the invention of the hand camera, a portable instrument that is often called a "detective" camera, from the fact that it made it possible to take pictures without observation. When the "wet-plate amateur" of olden times went out to make pictures, he was compelled to make known the business of his excursion in apparatus that would, as I have said, now seem very ponderous indeed. The modern amateur's outfit is exceedingly compact, even when he sallies forth with his tripod camera; and when his camera is a "detective" his burden is very light and inconspicuous.

The effort to make a hand camera that would not seem to be a camera has sometimes resulted in very curious contrivances. But we shall study cameras to better advantage in considering the things they are required to do.

CHAPTER VIII.

THE HOME GALLERY.

When the mercantile photographer fits up his gallery, he does so after certain accepted rules. His skylight has a certain angle, and if possible faces the north, so that it may have the full light of the sky, with no direct rays from the sun. His camera is on a carriage; he has sitters' chairs, headrests, reflecting screens, backgrounds, rustic railings, "grass" rugs, artificial vines, and other paraphernalia as his business may require.

Very few amateur photographers can ride their hobby with these surroundings. There are, indeed, amateurs who go into photography with a splendor of equipment far beyond anything that will be found in mercantile galleries. I know a lady who has a complete garden gallery, as well as a finely appointed studio in the upper part of her house; who has about thirty cameras, and who otherwise follows photography upon a plan of having every possible mechanical requirement. I know other home galleries, upon which thousands of dollars have been spent, which are fitted with luxurious conveniences such as no one will ever find in a "professional" gallery.

But such equipments are exceptional, and this book will take it for granted that the average amateur has no intention or expectation of taking up photography in this style. It certainly would be a very rash thing for any beginner to gather more than the simplest materials at the outset. When the beginner has become by experience a master or mistress of the science and the arts of its application, it is time enough to gather expensive implements.

It is a fact, however, that it is much easier to make pictures in a well-lighted gallery than in the light of an ordinary room; not only because there is more light in the gallery, but because the light is more favorably distributed, and falls mostly from overhead. For this reason the amateur should, if possible, have a home gallery with a "top" light or at least a high side light. A top light may sometimes be had from a skylight in an attic room. If it were thought desirable, a skylight might be cut in some large top-floor room, or in the more ample if less finished quarters of a barn or carriage-house. The expense of cutting a skylight will depend directly upon its size, and upon the slope of the roof in which it is cut. If the roof slopes sufficiently to permit the glass frame to be set directly against it, the arrangement will be simple and economical; but if the roof is flat or has only a slight pitch, it will be necessary to give a greater slope

to the glass frame, and the lifting and boxing of one end will complicate the affair. If the ceiling is rather low, that is, less than eight feet above the floor, it may be necessary to raise the skylight in any case.

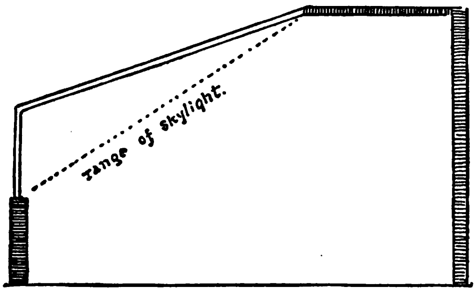


FIG. 13.

The conventional roof light joins with a sidelight, as roughly indicated in Fig. 13. A roof light alone, even when strong reflectors are used, is likely to cast strong shadows, which only the most experienced photographic artist is able to manage. The sidelight modifies these shadows, and helps, by the partnership of the reflectors, to fill the place with an amount of diffused light sufficient to give pleasant effects in portraiture; but only a specially constructed gallery, such as few amateurs possess, will have this combination. However, it may be possible in letting in a skylight to place it in line with a window. This will make something like the necessary combina-

tion, without interfering with the structure of the house.

If the amateur cannot have a roof light, and must get along with the side light of a window, let him get as tall a window as possible. If he is to have the room in which the window appears as a permanent gallery for indoor work, and can arrange it without necessity for change, the lower part of the window may be covered to a height level with the shoulders of a seated person. This covering should be dark, and exclude light at this part of the window. For the space of one foot above this dark covering, or to a height about equal to the top of a seated person's head, a lighter material might be stretched across the window, leaving the light to fall freely from above. This arrangement will give to the illumination of the sitter something of the effect of a light falling from above, or at a downward angle, and will give a much more artistic result than if the light from the window came horizontally to the sitter's face.

There is little use of attempting to imitate the "effects" of the professional gallery, not only because these will be very difficult if not impossible to secure, but because a home photograph will be much more charming for containing some suggestions of the home light. In fact, the photographs of the trade gallery often look unnatural, or at least unfamiliar, because the light is neither

the diffused downward light of the street nor the side light of the house.

Thus it is needless to seek to altogether destroy the effect of the ordinary window light. The necessity for the light at a downward angle is a necessity based on the advantage this angle gives in reflections. And here comes the great difficulty in the home gallery.

If the amateur were to undertake an experiment and try a portrait at an undraped window, and without reflectors, he would find the result to be this: a face strongly lighted on one side, the shadows all thrown from right to left or left to right, and the side of the head opposite the window dark and without relief. The strong side light probably gives a poor effect in the eyes, if both are illuminated by it, and the nose may keep all light from the "off" cheek. When the lower part of the window is draped, the amount of light is diminished, but the general direction of the remaining illumination is better than before. The brows cast a downward shadow, and the nose and lips appear to better advantage. The "off" side of the head, however, still remains unlighted.

This difficulty must be met by reflectors. I have improvised reflectors for an impromptu window portrait by covering the floor about the sitter with newspapers, hanging newspapers or other white sheets of paper or muslin under the nose of

the camera, and hanging up or holding up other white material opposite the window light and just out of range of the portrait. Of course in a room with white or very light walls there will be much less necessity for strong reflectors than in one with dark paper or frescoing. But in any case even the improvised newspaper reflectors are better than nothing.

For reflectors more conveniently arranged there are many plans. The simplest may be prepared in this way: A wooden frame about five feet high by three feet wide, with a supporting brace in the middle, is covered by tightly stretched muslin. The muslin should be either thick bleached sheeting or ordinary unbleached stuff painted with a preparation of whitening containing five per cent of glue.

A painted surface will throw a stronger reflection than the whitest goods, because the paint fills the grain and presents a flatter field. This frame may rest upon the floor with a chair or other object to support it, or it may be adjusted in a frame standing on rollers so as to be moved about from one position to another at will.

I may remark here that all the supplies for a gallery are to be had at places where photographic supplies are sold, but I give these hints on the presumption that most amateurs will wish to arrange their own appliances.

When placed in position the bottom of the

screen should be about twelve or fifteen inches nearer the window than the top, so as to cast light upward into the shadows. If it is placed directly opposite the window, it will have the effect of diminishing the shadow directly opposite the lighted side of the head and of leaving the strongest shadow in the middle of the face as it appears to the camera. By placing the screen nearer the camera and turning it so as to partly face the sitter, the lights and shadows will be more agreeably graded.

The background to a simple portrait may be made of some unfigured material, a deep gray preferably. Without such a background the objects of the room may disturb the harmony of the picture. If nothing without figures is at hand, hang the background far enough from the head to place it out of focus. The background material should be hung or stretched so as to be without wrinkles. Even when it is wished to have a white ground behind the head in the picture, it is better

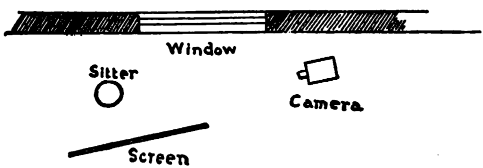


FIG. 14.

not to use a pure white material for the background. A light gray will photograph sufficiently white, and it will be safer, for reasons which will afterward be explained.

WINDOW PORTRAITURE

Showing effect of covering lower part of window and use of reflector. The first portrait is made without window covering or reflector; in the second the window covering is correct, but reflector is parallel with face of window — too far around; in the third the reflector is at the proper angle.

The camera should not be placed at right angles with the window, but so as to aim somewhat in the direction in which the light is falling. A proper position for the camera, for the sitter's chair, and the reflecting screen is indicated in Fig. 14.

The three portraits of a child taken at an ordinary window show the uses of a reflector. No. 1 is taken with no covering upon the lower part of the window and no reflector. In No. 2 the window has been treated properly, giving a much more agreeable upper light on the face, but the reflector is too far around — at right angles with the window. In No. 3 the reflector is properly placed.

If the camera contains a portrait lens, it will be possible to take relatively a larger head than if a landscape or general utility lens is in use. The portrait lens, being made especially for the work, will permit of a better position and a more favorable exposure. With an ordinary lens not made for portraiture, it is not well to get too close to the sitter in order to secure a large figure, for the wide angle lens will give an unnatural effect.

In taking a seated figure or figures, it is well to point the camera slightly downward, for the reason that the lower part of the figure will be nearer the lens than the upper part and a slight tilting of the camera will bring the upper and lower parts of the image more nearly in focus. A camera with

a "swing back" should be operated with regard to this fact.

If the figure is posed with any but a plain background, especially if with one having upright lines as in wainscoting, door frames, window casings, screens, etc., it becomes necessary to compromise. When he brings in accessories the photographer must have regard to them and must do them justice also. These upright lines must not be distorted in the aiming of the camera or in the use of the "swing back;" they will not all be perfectly upright in the negative if the plane of the lens is not parallel with them. The "swing back" can modify the difficulty to some extent, but not very greatly, should the lens be of wide angle and be brought close to the figure.

In any case it is a rule of portraiture to focus on the face of the sitter, and, if the picture is of the head only, on the pupil of the eye. Having focused on the eye or eyes of the sitter, the remainder of the head or figure must come within focus as it may. The farther the sitter is from the camera, the less will be the variation in focus between one part of the figure and another. In focusing, as in arranging, it is always to be remembered that in a portrait study the figure is *the* thing. If other objects are brought into the picture, as when a room with its natural furnishings is made the background — a very difficult thing to do artistically — care should be taken to re-

move at least very bright objects that will take a stronger light than the face. If bright objects are in partial shadow so that they will not glare, this danger is overcome. The trade gallery has a painted imitation of an interior, not because an actual interior might not be arranged under the skylight, but because the whole scene will then be on the same focal plane and will have no glistening or white objects within its field. This throws the figure into strong relief, an artistic necessity of portraiture. By allowing his background to fall out of focus, the amateur gives some of the same relief to the figure.

The best plan — for the beginner at least — is not to make composition pictures of a formal kind, but to attempt simple portraits, that seem to be what they are and no more. The "fixed-up" part of a picture always looks fixed up, and the thing that is most enjoyable in a portrait is — the portrait. However, if there is anything that must be arranged, in the drapery of the figure, in the adjusting of the hair or ornaments, or in the placing of the hands, give up whatever time is necessary to do the work perfectly. Sometimes, in photographing a child, for instance, the off-hand position taken before any instructions are given is better than any formal device that could be adopted. I say "sometimes." The position taken without care is very seldom the best position. A natural position is the best position, but this

does not mean the position that is taken without thought or even one that *feels* natural to the sitter. The art comes in making the position as seen in the picture *look* natural. A position that will look natural in the picture may feel unnatural to the sitter, but there are peculiarities in the lens and in the eye that make it necessary to think only of how the effect will appear in the resulting picture.

Skill in posing a sitter has to be acquired by study and experience, and the beginner must not lose patience if his early attempts lack something that they should have. The beginner must not lose courage if the portrait over which he has taken a great deal of trouble does n't result so favorably as the portrait which was taken haphazard. This does not mean that it is not a good idea to take pains; it only means that pains and experience have not yet gone far enough.

Let me offer in a consecutive way some special hints on work in the home gallery.

THE SUBJECT. Since the amateur does not generally have so much light as the mercantile photographer, and since he wishes to get along without the iron head-clamp we used to meet in the professional gallery (what a chill it gives you! — like the first touch of the steel when you are going to have a tooth pulled!), he should have his sitter firmly seated against the chair back, particularly if it be a very young sitter. In the case of children, contrive to have the head

steadied in some way, unless there is a brilliant light and the exposure is to be very short. Perhaps the background screen or drapery may be brought close to the chair, and the head may be steadied by some unseen object (perhaps another chair) from behind; for the sitter should be absolutely still during the exposure. Even with a good light and a large stop, the exposure will probably occupy two or three seconds, and in half a second a restless sitter can move a great deal. Where you have a very young patient, with no patience, leave out the stop, and possibly a second will do; even with a lens used for doing all sorts of work a larger stop may be used for portraits than for landscapes. The "exposer" operated with a long rubber tube and air bulb, and capable of giving a short or a long exposure, is almost indispensable, especially for taking the baby. It is very hard to dance around and say "Hi, yi!" and wave the fire tongs, and calculate the pose of the head and whether the expression is favorable, and at the same time take off a "cap" successfully.

If a view lens is being used do not take profiles at too close quarters, or the ear in the negative, having been so much nearer than the other features, will astonish you!

It is generally inadvisable to have a person of light complexion, and particularly with blue or gray eyes, face *toward* the light. A person with

dark eyes may turn toward the light; and a person with deep-set eyes, even when these are gray or blue, can seldom be turned from the light. Never forget the hands! If they must be nearer the lens than the face, see that they are well placed. A person often relaxes the hands under what seems like an operation, and tempts the lens to make them seem unnaturally large. Induce the sitter to take charge of his hands, to gather up some of the fingers, to hold a book or fan or photograph. Of course, when the picture is to be of the bust only, it is unnecessary to do otherwise than have the hands resting in the lap.

See that the sitter's hair is properly arranged; that is, whether it is to be formal or negligée; see that there are not stray locks, or pugnacious tufts on the crown that would not look satisfactory in the picture. What you shall do in these and in other particulars will depend to some extent upon whether you are making the picture according to your own ideas, or to please the "patient" and his friends. In any case it will pay to consider what the sitter will say. When the sitter says, "I wish I had known my hair was that way — that just spoils the whole picture," the photographer, even though he feels justified in suiting himself, will feel a regret that he did not save himself the annoyance of having his subject dissatisfied.

Much of the naturalness and interest of a por-

trait will depend upon the eyes. It is always safe to have the eyes directed toward the camera; but there is a safe general principle that if the head is turned either from full face toward a profile or from a profile toward the camera, the eyes should be turned a little farther than the head. The eyes always precede the head in turning. There is a prejudice among photographers who make portraits that look like neither life nor art, in favor of having the pupils of the eyes precisely in the middle, however the head may be directed. Of course this is a great error. In looking toward an object to the right or left, we never turn the head far enough to bring the pupils precisely in the middle between the open lids, and attention to this point will have much to do with the success of a portrait, for the turn of the eyes supplies much of the action of the picture.

One caution must be offered, however, in the carrying out of this good principle. The eyes cannot be turned too far away from the lens if the face is in profile, or is very nearly so. In fact, in a complete profile it is necessary to turn the eyes slightly toward the side on which the camera is placed. If this precaution is not taken the pupil may seem to have turned farther than it has, and the eye will appear unnatural.

The most unfortunate of all blunders with the eyes, yet one of which we may find examples in any album of portraits, is seen in those cases where

the head has been turned, let us say, to the right, while the eyes have, by the photographer's instruction, been turned to the left and toward the camera. This blunder explains the stiffness and unnaturalness of more photographs than are to be explained by any other blunder I have ever noticed.

Don't make the sitter suffer for his physical defects by trying "effects" that have been produced successfully with sitters who did not have these defects.

THE CAMERA. — Focus without the stop, that you may be the more certain of absolute "sharpness" at the point chosen for the focusing.

Have the camera firmly placed, especially if it be used when there is near-by street traffic or other chances that the floor may be shaken. If an air-tube exposer be used, do not make the action violent enough to jar the camera should the apparatus be so constructed as to make this possible. If the exposure is made with a cap, loosen the cap cautiously for the same reason; lift it *upward*, and return it from the upward side when covering the lens again. By raising the cap and returning it from the upward side, the lower part of the outer lens receives the more light and the more highly illuminated upper part of the subject receives slightly less exposure than the lower part.

Have some means of marking the exposed side of the plate-holder. It is very annoying, when

the sitter inquires for a print, to be compelled to admit that both exposures have been made upon the one plate. Holder slides that are reversible and that indicate by the reversing that an exposure has been made, are a safe means of avoiding this trouble. But a label on which remarks as to time, light, etc., may be lightly traced in lead pencil, is also useful and sufficient.

On the ground side of the focusing glass at the back of the camera, mark out the sizes, upright and horizontal, of the plates used in the holders; so that if a portrait is being made on a 4×5 inch plate in a 5×8 inch holder, the outline of the 4×5 inch size may enable the operator to locate the image in the proper place. Be sure that the head or heads are high enough on the plate. In a bust portrait it is particularly important that the head should be well up on the plate. If the face turns toward one side or the other, leave more room on the plate on the side toward which the face turns than on the opposite side. The side of a picture toward which a figure faces, or toward which the action is directed, is the side which must have the widest margin.

INTERIORS.

Lighting being the great difficulty connected with photography indoors, we can see why the picture of an "interior" of an entire room or of several connected rooms should be more difficult

to photograph than a person. We may place a sitter near a window and, by the use of a reflector and other devices, produce almost any effect we choose. But the room cannot be moved, and — what is more disconcerting — neither can the windows.

A window opening practically represents out of doors so far as the time required to photograph it is concerned. Draperies and shades will, of course, modify to some extent the brilliancy of the light; but in lessening the brightness of the window opening in the picture, we shall be lessening the illumination of all the objects in the picture. Moreover, other parts of the room require perhaps a hundred times longer exposure than the windows. It is plain, therefore, that something must be done to overcome to some extent this troublesome difference.

A little later I shall speak of artificial methods of lighting a room, but at present we may look at some measures for using daylight. The simplest method of doing this, and the one most frequently followed, — as the reader will notice by studying the pictures of halls and galleries gathered by tourists, — is that of choosing a point of view that will not include the actual openings of the windows. In doing this it is wise also to select a time when the sun is not beating in; and if possible get most of the light from one window, or from two windows close together, so that the

shadows on the floor and wall will not cross each other in a disagreeable way.

When a window comes within range, and there is no way of avoiding it, cover it up with a blanket or shawl, so that no light may come through; then get the illumination from an adjoining window not in range, and hang reflectors in such a way as to light up the dim corners. Two or three large sheets and many newspapers may be required. Perhaps there is a window on the opposite side of the room that will obviate the necessity for using the reflectors. In some instances it may be possible to overcome obstinately dense shadows in unlighted parts of the room by taking a hand mirror and keeping its reflection moving over the dim places during the time of exposure. (I once did this patiently for half an hour, and then discovered that I had forgotten to remove the cap from the lens!)

If there is no hurry, use a small stop for this work, and give the room half an hour, an hour exposure, or longer if need be. When the exposure is completed, replace the cap carefully, and remove the covering from the window (taking care not to move any of the objects in the room), and give the whole half a second or less exposure, as the character of the window draperies and the amount of light out of doors may suggest.

It is natural and not ineffective that there should be more light in one part of a scene than in

another; but if light is too greatly centred in one part of a room, the corresponding part of the plate will be overdone, as it were, before the other parts of the plate have received a sufficient impression. The contrast between light and shade being exaggerated in photography, it is particularly necessary that the illumination should be as evenly distributed as possible. With every care the high lights often will be altogether too "high," and in the subsequent printing from the negative the effort to print out the objects in the well-lighted part will result in the obscuring by overprinting of the objects in shadow or half shadow.

I have already mentioned obtrusive objects in a room. While it is not a good idea, in photographing a domestic room, to have the place so transformed in order to look artistic that it is afterward, in the picture, unrecognizable as a familiar scene, there is no harm in a certain kind of arrangement with a view to preventing discordant light and dark objects from disturbing the effect. Exactly how much of arrangement or of leaving out should be done, the photographer's taste must decide.

While the difficulties of focusing make it necessary to arrange objects with this fact in mind, the matter of arrangement, of composition (in tables, chairs, piano lamps, or other movable objects), must be regulated largely by the general

principles of art. For hints on "interior" composition, study the works of the best painters and illustrators.

The photographic beginner who undertakes to immortalize the various nooks of home will often be pressed for room to work in. A few feet may be gained in this way: Focus upon a point dis-

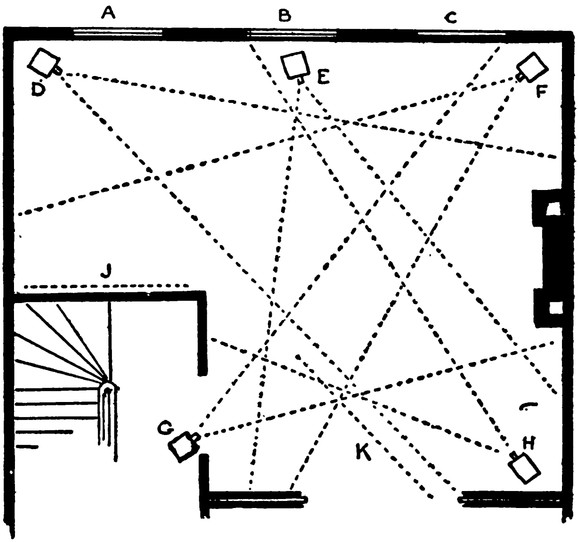


FIG. 15.

tant from the camera about as far as four fifths of the distance from the point where the camera is to stand and the farthest object which you wish to include in the picture. Then put in the plate-holder, remove the box from the tripod, and place

it on a firm stand, table, or perhaps a library shelf from which books have been removed, against the wall or in a corner. This will secure a much longer and wider range, and it will be easy enough to guess the general direction in which the lens should be aimed.

Some hints upon plans for photographing an ordinary city "alcove" chamber or library are furnished by Fig. 15. A camera at D, E, F, or G could be operated without the covering of any window. H would call for the covering of the window A, and would need a reflector at J. Working from D, a reflector might be used at K. The camera at D, unless all the objects in the room are close against the wall, should be focused upon a point as far distant as the letter K. Any room may be photographed on the same principles.

One precaution is extremely necessary in photographing interiors; and if I may judge by the number of pictures containing a certain distressing defect, it is always advisable to point out this necessity. In focusing be careful to adjust the camera so that the vertical lines shall not draw together, or, what is more distressing, lean outward at the top. With a lens that is not rectilinear, that is to say, "corrected" to avoid the defect of a curvature in all the outer lines, it is impossible to avoid a tendency, in both upright and horizontal lines, to fall into the turns of the circle. But with a good lens there is no excuse,

and the lines to right and left should run precisely with the margin line of the plate.

I say "no excuse;" but where the camera has no swing back and it is impossible to direct it on an absolute level, a certain distortion will be unavoidable. With a swing back, as already explained, it is possible to avoid the disagreeable disturbance of lines in all except the extreme cases where the camera must be pointed upward or downward. With a hand camera a care for the level of the box, both in quick exposures without a rest and in time exposures with some support, will insure against the undesired effect.

CHAPTER IX.

FLASH-LIGHT PHOTOGRAPHY.

If photography were confined to picture-making by the direct or diffused light of the sun, it would miss many agreeable and important advantages that it now possesses.

Realizing how good a thing it would be to make pictures by the aid of light other than that supplied by the sun, many of the early photographers experimented with oil light and gaslight, and with other kinds of illumination. The earlier plates were so "slow," and gas and oil supplied such a yellow light, that the early experiments were tedious and unprofitable. With more sensitive dry plates it became an easy matter to photograph rooms by gaslight. The effect of pictures produced in this way is entirely agreeable, but the time required is always a serious drawback. I remember photographing myself by gaslight — in charity I was my own first sitter. I sat for twenty-five minutes, and there is no likelihood that I shall ever forget how disagreeable the experience was.

The use of gaslight always has the objection

exposure and the lighting so as to give a desirable effect. Other flashes may be produced several inches apart. In using the flash from more than one point, remember the desirability of an illumination that comes from one general direction. Crossed shadows are unpleasant where they have not an effect consistent with the familiar lighting of the room.

Agreeable pictures are sometimes made by using the magnesium in a fireplace, that room and figures may be illuminated as if by firelight. An artist friend of mine has produced very realistic camp-fire studies in this way. Of course the flash itself must be hidden by the use of a chair or a silhouetted figure.

The intensity of a flashlight is much increased by the use of a large sheet of cardboard or some other reflector, slightly curved, and fixed behind the light at a distance of about eighteen inches. The quantity of powder and the size of the reflector always depend upon the size of the room in which they are used and upon the color of the walls. If the walls are white much less magnesium will be necessary than in a room with darkly colored walls, since the walls and ceiling themselves act as reflectors in diffusing the light in the apartment.

The magnesium light, as well as the electric light, has been used in photography out of doors. An excellent portrait of Bartholdi's Liberty in

New York Harbor has been produced at night in the light of a big magnesium flash. In such a case the result is, however, more novel than practical. The same thing may be said of a great many night pictures out of doors. Yet there is often much that is interesting in pictures of public squares, buildings, etc., made by the light of their own illuminations.

The photographing of self-luminous objects is, indeed, an attractive phase of picture-making. Fireworks displays are very happily reported by the camera. Often the negatives made from such displays not only exhibit the effect of the different pieces, but convey an excellent impression of the scene as a whole in the light of the pyrotechnics.

Perhaps there will not be a better place than this to speak of photographs of lightning. These are best when made at night, the flashes then being in greater relief, and the general darkness permitting the exposing of a single plate to the action of several flashes. The most fortunate conditions for getting fine studies of the electric rivers (for such the quickly traveling sparks appear to be) are those which include a view of a broad stretch of horizon. In a city such a view may seldom be had save from an upper window or the housetop.

CHAPTER X.

RAMBLES IN NATURE'S GALLERY.

In nature's gallery — in the streets, in the fields, and on the sea — there is still a problem of lighting, but it is very different from the problem which we have to consider when we photograph objects indoors.

The light now falls from above, in an intense flood at midday in summer, in a yellower and less actinic flood at midday in winter, and in diffused rays when the sun is obscured. It is necessary to pay some attention to these matters of *quality* in light in beginning to practice outdoor photography; to remember that the light is brightest when the sun is highest, and that as the afternoon advances the sun's rays not only become less bright to the eye, but by becoming yellower are less suitable to photography than might at first be supposed from the judgment of the eye. The plate thus will require a longer exposure at 4 P. M. than at 2 P. M., though often on a very clear summer day in the open country the difference in the actual working power of sunlight at two and at four o'clock is extremely slight.

The difference in strength between winter and summer sunlight is very great. As the sun lies lower in winter, its rays, as we receive them, are yellower, and the earlier sunset greatly shortens the time when photography is possible; yet winter photography out of doors is a delightful recreation. Jack Frost's fairyland is an enticing subject. No painter's brush can suggest the infinite delicacy of the ice formations on shrub and tree. The camera, when properly managed, catches every glitter of the snow crust and icicle. Again, the pictures of the snow house, the farm or city park draped in white come with pictures of winter sport — the sleighing party, the toboggan, the snowball battle, the skaters' race.

But for many reasons other than that of the better light, the summer is particularly the photographic season so far as out of door work is concerned. In summer the temperature is more congenial to the fingers that must fuss with tripod, carrying case, screws, focusing cloth, and stops. There is less wind to bother the operator, and better opportunities in selecting figures and incidents.

Each season has its opportunities and its drawbacks, and the student of photography must study and consider both.

Outdoor photography is practiced both with a tripod camera and with a hand camera. I shall leave for another chapter some hints upon the use

of the hand camera. In the present chapter we shall talk about the camera "on legs."

The camera which the photographer carries out of doors should be light, strong and easily managed. It should go into small space, and should be so built as quickly to be placed in readiness for operating. Recent improvements in camera-making have been in the direction of lightness, and there are many clever devices that do away with the old-fashioned screws that took so much precious time and so much patience to manage.

In packing the camera and implements form a habit of placing each article in the carrying case in precisely the same way each time. By so doing it is possible to avoid the disagreeable chance of leaving something out that should be carried along — the little case of diaphragms, for instance. A place being provided for everything, everything is much more likely to find its way to a place. The lens may be carried in a separate bag with a drawing string or flap, or in a tightly fitting box, and then stowed in a certain corner of the carrying case. If it is carried in the camera by reversing the front piece, it should be carefully capped and the reverse side protected in some manner from dust or chance of scratching. Some lenses are provided with a sliding band that can cover the slot used for the insertion of the diaphragm. When there is no such wise provision it is well to

leave a diaphragm in the lens to prevent in some measure the entrance of dust.

It is a good plan to have a bag for the plate-holders, which when safely covered in this way are in less danger from sunlight than if exposed from time to time in the unpacking and setting up of the camera.

In setting the tripod be careful to give it a solid footing and to give to the camera as nearly as possible a perfect level, unless there is some special necessity for an upward or downward aim. If the wind is blowing strongly (as it often does during work on the seashore and the mountains) and the tripod is slender, it is desirable to anchor the apparatus in some way. Thus a string fastened to the top plate of the tripod (perhaps by the screw or lever under the plate) may be attached to a stone sufficiently heavy to act as an anchor. This will be better than weights against the feet of the tripod, since it will bring the steadying influence from the centre. Focusing cloths are sometimes made with a gathering string or an elastic band, by which they are secured to the camera. During the exposure these coverings, which are often of light waterproof cloth, are a screen to the joint between the plate-holder and the camera. In windy weather the ends of the focusing cloth should not be permitted to flutter during the exposure.

The caution already offered as to the necessity

for removing the cap with sufficient care to avoid the jarring of the instrument, applies to quick outdoor photography as well as to operating indoors. The slightest tremor of the box caused by carelessly removing the cap will destroy the clearness of the image in some degree, and sometimes cause a total failure. A gentle swaying motion, as on a ship's deck, will do no perceptible harm, provided the exposure is quick enough; but an oscillation such as that created by a loose fastening to the tripod, or other causes I have mentioned, must be avoided.

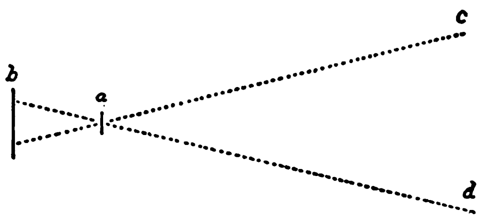


Fig. 17.

Why the movement of the object to be photographed does less harm than the movement of the camera, may be explained by the accompanying diagram. Taking *a* for the lens, *b* for the plate, and *c* and *d* for outside rays of light crossing each other at the lens, it will be seen that the point of intersection (*a*) being about four fifths of the distance from *c* and *d* to the plate, either of these points might be moved an inch

before the points which touch the plates would move a quarter of an inch. The reader may illustrate this himself by holding a stick between two fingers near one end, and moving the end farthest from the fingers. Imagine the points *c* and *d* at a distance a hundred times greater than that between the plate and the lens, and you have a suggestion of the range of the lens at fifty feet when the lens has a six-inch focus, as well as an illustration of slower movement on the plate of a ray coming from a quickly moving object.

Naturally, then, the greater the distance from a moving object, the better the chances of securing a "sharp" image. A person walking with ordinary rapidity might be very difficult to photograph at a distance of six feet, while at fifty feet the camera can capture the fleetest runner.

For the reason that the camera can often be operated free of the tripod, as well as because focusing occupies much time, a "finder" and a focusing scale are useful features of a tripod camera which may be mentioned here. A finder is a device containing a small lens and ground glass, which by attachment to the top of the camera reveals (approximately) to the operator the field covered by the lens. There are simpler devices giving the eye the angle of the lens (which may be found by a little experiment), such as a piece of bent wire.

The focusing scale may be marked off on the

sliding track of the camera after a careful test upon points duly measured off. The distances noted on the camera may be many or few as the operator chooses; but as the eye cannot more than roughly estimate a distance, a few marks will suffice. Thus the scale may be drawn as in Fig. 18.

If this scale is carefully made, and if the camera works compactly, when the slide-rest of the bellows is set at any particular figure the camera will be accurately in focus for objects at that distance. The last mark, as the "100" on the figure herewith, should represent the "universal focus" of the lens giving the best results for a general view including distance.

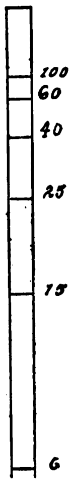


Fig. 18.

Selection. One of the beginner's most probable mistakes in landscape photography is that of trying to take too much. In seeking "views" the beginner is likely to reach out for a wide range of country when he can find points of view commanding such expanses. The simple but charming roadside spring, with the bit of broken fence and the splash of wild flowers, is passed by for the view across the valley; but the spring would make a picture, and the valley may be a great disappointment when printing time comes.

I do not mean that the valley should never

be photographed. With a plate of suitable size and a lens of good quality, great distances may be pictured in a manner to call up much of what delighted us in the original scene. If a broad landscape includes a horizon range and much remote detail, the photographer should seek to frame in the view with the aid of foreground objects. Without near-by trees, rocks, or figures, the picture must lose, not only the natural effect of distance and perspective, but the beauty of composition that goes to make a picture. If there is but a single foreground object — a bold upright is always useful — do not bring it into the centre of the picture, but introduce it by moving the camera to the necessary position, near either side. There are times when no interest of this kind is offered by the view, as when a treeless plain leads to the foot of a row of hills. In such a case it is necessary to be cautious in fixing the horizon line. If the ground is flat and unbroken in front, keep the horizon line low, especially if there are clouds to be had. When there is much interest in the foreground, the strong horizontal line of the picture may sometimes be effectively placed above the middle of the plate.

Atmosphere softens so much of the distance, and the predominating blue so strongly affects the plate, that extended views are less satisfactory than pictures with a background, or pictures depending for their interest on objects com-

paratively close at hand. The principles which should guide the photographer in arranging the material he selects are principles which he will be able to study in the pictures of great painters and illustrators.

LANDSCAPE FIGURES. Whether a figure or figures in a landscape will be an advantage or not, will depend upon the purpose of the picture. If the picture is to convey an impression of the vastness and lonesomeness of a scene, the absence of any signs of life will be an advantage. On the other hand, a farm scene is generally improved by a glimpse of cattle, of the milkmaid, of the cowboy, of the farm hand at the hayrick, or of the farmer himself at the bars. A picture of a roadside spring is improved, perhaps, by a figure with cup stooping to drink. But every figure should be carefully introduced, so as to look entirely natural, and not posed, or it is better to leave out such an attempt altogether.

LANDSCAPE LENSES. There are many varieties of landscape lenses especially designed for landscape work, but a good "all around" lens will be the kind the amateur will usually be found using. One containing a fixed rotary diaphragm is useful in the field. The new exposers, combining diaphragm and "shutter," are a luxury worth having.

FOCUSING. Focus before putting in the diaphragm. If the interest is in the general land-

scape, allow the immediate foreground to be out of focus, and focus upon the distant objects. If the near objects are the particular subject of the picture, focus on a point in the midst of these, always beyond rather than within the line chosen. Of course in the case of a house and its surroundings, the focus must be upon the face of the house, as upon the face of a person in a portrait, letting other objects and the distance fall out of focus as they may. A background out of focus is often a decided advantage rather than a detriment, since its softness throws the objects in focus into fuller and more artistic relief. Focusing is made easier, especially to those whose eyes are not keen, by the use of a focusing glass, a magnifying lens set in a short section of tube. The tube, resting against the ground glass, shuts out all light, even without the aid of a cloth, and the magnifier enlarges the section of the lens's image to such an extent that it becomes quite easy to focus accurately. After focusing, put in the stop.

STOPS. If there are no moving objects and no wind, a small stop may be used with two or three seconds' exposure. If there is movement, demanding a quick exposure, the size of the stop must depend upon the quickness and nearness of the motion, and the amount of light. In a city street, even at high noon, there is less light than in an open field at the same hour, less light in an open

field than on the top of a hill, and less even on the top of a hill than on the open sea. Perhaps in an instantaneous exposure you will have to work with no stop at all. Without a stop, the lens not only works less "sharply," — though this will not be much of a detriment in many pictures, — but it does not illuminate such a wide surface, and the plate, if larger than the lens is intended to cover without a stop, will show a dimness at the edges. This is to say, that while a lens open, without a stop, admits light more quickly, a lens with a stop distributes the same amount of light over a wider surface and more evenly.

PORTRAITS AND GROUPS. Outdoor portraits are in many respects much easier to make than indoor portraits. The lighting of the subject is so difficult a matter, when undertaken at an ordinary window, that the amateur may well be inclined to lure his sitters into some favoring corner under the generous canopy of the sky, where the question of lighting is settled without much labor. Here we shall not get so fine a quality of lighting as when the illumination is adjusted, but the result is often all that need be asked.

There are times when figures may be taken in full sunlight. Indeed, the brilliant gilding of the sun often gives a charm not to be approached by a quieter coloring. But this method has many risks. While sometimes good in compositions, it is unsafe for careful portraiture, because the face

is generally thrown into dense shadow or lighted in a patchy, undesirable way. The nose has a great partiality for the sun, and will frequently obtrude itself in a state of gorgeous illumination when the rest of the face is as dim as night. Thus the sunlight is favorable for anything that is fantastic or picturesque, rather than for quieter work in which a likeness is desirable.

In general it is best to choose a time when the sun is obscured, or a position out of the direct rays, in the shadow of a building or other prominence. Here the light, reflected freely from the sky, while not furnished by the direct rays, will be soft and diffused. For portraits of the full figure the natural background of the house or of some shrubbery may be acceptable. Unless the background is unobtrusive or perhaps out of focus, it may be better to make head portraits with a gray background of some sort, hung so as to show no texture lines or wrinkles. The ideal background for a head is one that does not suggest any material when the print comes to be made, but merely appears as a gray relief for the head.

It is especially difficult out of doors to secure a pleasant and natural expression of the features. On a bright day, even in the shadow, the brows of the sitter may be seen contracting under the force of the light. If the light bothers the sitter perhaps some change of position may overcome the difficulty, but usually a reminder not to pucker the brows will be sufficient.

This tendency to distort the face in a strong light makes outdoor group photography very trying. In a proper group each individual should be favorably taken, yet to do full justice to all is a problem of much difficulty. A score of artistic annoyances intrude themselves. Hands and feet may be depended upon to supply an inexhaustible source of trouble in group-taking. Look carefully to all the hands and feet, to the direction of all the eyes, and to the arrangement of the clothing in the case of each member of the group, before making the exposure. The "last look," at the word "Ready!" often detects a flaw that might disfigure the result.

One of the chief objections to outdoor portraiture is the "dark faces" of which the sitters complain when prints are shown. To partly overcome this drawback avoid very light backgrounds or accessories, and persuade the sitters not to wear white outer clothing. Neither very light nor very dark clothing is favorable to open-air portraiture.

CHAPTER XI.

THE HAND CAMERA.

THE hand camera is the petted darling of modern photography. This portable instrument was the natural outcome of the invention of "quick" plates that permitted the taking of pictures at so high a rate of speed that an absolutely stationary camera became unnecessary.

Its elements are a camera obscura or "finder," and a mathematical focusing lever, which do away with the ground glass and head cloth, and an automatic exposer, which may be liberated by a trigger. Freed from the tripod, carrying case, straps, and plate bag, the hand camera is endowed for a nomadic life. It can go everywhere, and, such is the enthusiasm of the modern amateur, it almost does.

There are hand cameras and hand cameras. Although but a few years have passed since the first instrument made its appearance at the Patent Office, the multiplication of designs has been surprising — surprising in more senses than one, for not a few of the so-called "detectives" are very clumsy and all but worthless. Primarily, these

cameras are all intended for use in the hands, and without a rest. They are also more or less disguised, so as to attract as little suspicion as possible when being used stealthily. At present I can recall only two or three well-disguised cameras out of the scores I have inspected. Unless the disguise is complete, there is scarcely necessity for any at all. For most uses there is no need for disguise.

In selecting a hand camera, it is just as necessary, as in the case of the tripod camera, to determine, in some measure at least, the use to which it will be devoted. It sometimes seems as if no two people agree as to what the "detective" was invented for. Some maintain that it was especially devised to capture the baby, who can be tracked all around the yard, and caught at last when expression and attitude are most favorable. Certainly the hand camera is very useful in this direction. The baby does not fear or even notice the portable box, while the camera on legs often has an appearance that is absolutely threatening. Others fancy that the "detective" was designed for picnic expeditions, when no sensible person wishes to add tripods and carrying cases to the already considerable burden of lunch baskets. For his part, the professor regards it as made for scientific excursions; and Mr. Banker, who carries it to and from his office, says it is the only kind of camera he would be

bothered with. The tourist takes it through the capitals of Europe, and sends home in "blue prints" to his friends a pictorial history of his journey.

I say here and elsewhere "his," but only because the grammar of our language makes the word necessary. The amateur photographer at home and abroad — yes, even in the wildest passes of the mountain region — is as likely to be "Miss" or "Mrs." as "Mr."

For what I might call "free-hand" outdoor work, a good single-lens camera answers very well; but of course the limitations of a single lens will be just as apparent in hand-camera work as in any other, when the subject is such as to place a severe test upon the instrument. Whether the lens be single or double, it must be quick, or it cannot render good service in a hand camera. And here it may be noted that a lens's depth of focus has much to do with its speed. The average hand camera is fitted with a short-focus, wide-angle lens, which has great advantages in a portable camera. In the first place, a short-focus lens has greater rapidity than one of long focus. Every inch that the rays of light have to travel after passing through the lens will represent an increase in the length of time required to produce an impression on the plate. This increase may be so slight as to be difficult to measure. Yet it is an actual increase, and it is

for this reason that very rapid work with a large camera is extremely difficult. Scientific work, such as that done by Mr. Muybridge with the horse in motion, is generally conducted with a relatively small camera, and enlarged as may be necessary.

Again, the short-focus lens gives greater "depth of focus" than a lens of longer focus. I may illustrate this by saying that lenses are made so short in focus as to be operated without special adjustment. They have a universal focus, and give a sharp image at six feet as well as at six hundred. Other lenses, designed for special classes of work, are so long in focus that if focused on a point fifty feet away, objects at either forty or sixty feet will be out of focus.

The defect of the very short-focus (wide-angle) lens is its exaggeration of the perspective lines. The defect of the long-focus (narrow-angle) lens is that it does not bring so many objects in focus, and does not cover so wide a field. The advantage of the short focus is its rapidity and its universally sharp image. The advantage of the long focus is the naturalness of the perspective, and its capacity for reproducing objects in good size without approaching so near as to make the speed of their movements difficult to photograph. Photographers of racing scenes, — walking, running, hurdling, — of football, and other athletic contests, use a camera with a comparatively long

focus and a lens capable of very quick action. With such a camera the photographer may, for instance, secure a rapidly moving figure three inches high without approaching nearer than twenty feet.

For general hand-camera work, with a box giving a 4×5 inch picture and suitable for general outdoor "sketching" as well as indoor studies upon occasion, I would recommend a lens with about a six-inch focus. The perspective lines produced by such a lens will closely resemble those drawn on the retina by the human eye.

Perhaps the most important thing to learn about the hand camera is what it will *not* do. "Press the trigger," says the card of instruction, and there you are. It is very easy — to press the trigger. Unfortunately for lazy people there are a few other little details to be attended to, and even when everything is at its best the chances for failure are numerous. This is an inventive age, and we live in such a very smart country that it is difficult to believe that we cannot, as it were, "drop a nickel in the slot," and produce almost anything. The disappointment of discovering that to "aim and fire" with the camera gives no assurance of a good picture, is frequently great; but it is a wholesome disappointment, because it calls attention to the fact that photography, even with a patented box, is something more than the agitation of certain machinery.

SUNSET ON THE ST. LAWRENCE

From a Photograph by James Stebbins, Jr.

Although the portable camera is operated in the hands, it is necessary to remember that it cannot safely be suddenly jarred in the operation. The camera should be held firmly, especially when the shutter is set for a low rate of speed, and should not be jolted by the pressing of the trigger. I have seen dozens of plates successively spoiled by the "punching" of the button that liberates the exposing apparatus. The finger operating the button should be laid upon it firmly, and in applying the pressure the box should be so held as to resist any tendency to sudden movement that might result from the quick touch of the "trigger finger." As I have said already, a swaying motion is quite safe when the exposer is set for high speed, so that there is no difficulty about following with the eye the movement of an object on the finder until the instant for a favorable exposure arrives.

The expert operator naturally is able to use a much slower shutter, without danger to the image, than the beginner will find it safe to adopt. In "shooting" from a boat or from a moving vehicle, hold the camera free from the body, standing with knees bent and on the toes if need be, so as to prevent jolting movements from being carried to the box.

Each form of camera will require its own plan of operating so far as the mechanical matters are concerned. A plate-holder camera, a camera

with a back section for taking in plate-holders and a door for drawing the slide, requires one method. A "magazine" camera, a camera holding a number of plates successively carried into position by certain mechanism, calls for care of a different kind. Another form is the "roll-holder" camera, with a panoramic film, turned piece by piece, and permitting as high as a hundred exposures. In different cameras different precautions are necessary as to the exposers. Some have to be set each time, and the photographer must be careful to shut the front opening of the box so as to avoid exposing the plate to light when preparing the exposer for operation. Some have a watch-spring shutter which gives continuous exposures upon pressure of the button. Others have "setters" that do not move the shutter, and consequently do not endanger the plate in case plate-holders are in use and the slide has been drawn.

Whatever the variety of camera, form a particular habit in operating, so that, in a hurried moment, the hands will follow the necessary movements, without a thought for each. Have a rigid rule with regard to plate-holders, that no confusion may arise as to which contains exposed and which unexposed plates. In the case of a roll-holder, adopt the habit of turning the roll to the next notch immediately after each exposure.

If these good habits are not adopted, there will

be many moments of doubt and annoyance, many "blanks," and — worse still, because of the greater loss — many "doubles;" for hand-camera photography is often decidedly exciting. There is a demand for quick thinking and quick action, and the chances of accident are proportionately great.

Negatives made with the hand camera, being generally products of a short exposure, are more likely to be under-exposed than negatives made with the tripod camera. It often seems to be necessary to remind the beginner with the hand camera that there is really nothing magical about its power, and that it will no more make pictures without light than without a lens. The portable instrument is so often spoken of as an "instantaneous camera" that it is quite easy to discover that there is some theory of superior speed in the contrivance. The basis of the rapid action being in the lens and the sensitive plate, the form of the camera has nothing to do with the capacity for quickness.

Do not, then, expect the hand camera to perform marvels, to take pictures when or where there is not sufficient light. Do not set the exposer for a high speed when there is little light and little movement. Give the plate a fair chance.

Until he has had much experience the photographer will be dependent upon the "finder" in taking aim. If he has the knack of becoming a

good camera marksman, he will be able after a time to shoot without the guidance of the finder, as the good pistol marksman does without glancing at the "sight."

The "detective" is a very companionable affair. It is such a good traveler that it continually receives preferences. It goes to the presidential inauguration; it goes to the county fair; it goes to the garden party; it goes in and out of the crowded "quarters" of the great cities, and up the peak of Chocorua. It is a kind of instantaneous notebook, in which is being taken down all the outdoor happenings of the world. The enthusiast who long has made it his companion, who has learned to trust and to feel a kind of affection for it, is inclined to paraphrase a familiar saying and maintain that a camera in the hand is worth two on legs.

CHAPTER XII.

THE NEGATIVE.

In an earlier chapter we saw how the action of light upon certain forms of silver permits the subsequent darkening of the substances affected by the light. There is no occasion here to explain in detail precisely what chemical action takes place when the "developer" follows up the action of sunlight. As a matter of fact, this chemical action never has been fully determined by the chemists. It will be sufficient to explain in a general way what the sensitive surface undergoes in the making of a negative.

The oxidization or decomposition or other action in the film of the plate resulting from the exposure to light gives no sign discernible to the eye until the sensitive surface has been treated with a "developer." The image before development is spoken of as "latent." The sun has done its work, and nothing in chemistry sounded more marvelous than the claim (now disputed) of these myriad molecules set in new motion by the sun, and remaining in this action for months and years perhaps, until the touch of a developing

agent darkens the places where they have been quivering.

Thus, while we speak of the plate as remaining white after the exposure and until the development, the plate really has undergone a change in the parts touched by the light and in proportion to the intensity of the light. After the developer has acted upon the plate, the precipitated silver in the emulsion of the plate is found to have been reduced to a metallic state wherever it has had the combined action of the light and the chemicals used in completing that action.

Every other process at which we have glanced, every precaution as to light and length of exposure, comes into court for judgment when the plate is covered with the developer. The action of the plate surface in the developer is not an absolute test of the correctness of the exposure. Before this could be so we should have to know positively that the coating of the plate, which we have bought in a package of a dozen, had been properly done, with the right ingredients, without accident of any kind, and that the plate had been free from any injurious influences of heat, cold, or dampness in the mean time. We should require to know also, what is almost as difficult to know, that the chemical ingredients of the developer were above reproach, and that the water in which they were mixed was absolutely pure. All these things, I need hardly say, are not easily known.

Yet, having made every effort to get good plates and having taken every reasonable care with the chemicals of the developer, we shall be able to say that the conduct of the plate in the developer generally represents the success or want of success with which it has been exposed in the camera. If it has been exposed too short a time, only the "high lights," such as the sky in a landscape, the glitter on light objects in a room, the white of the face or linen in a portrait, will appear, if the exposure has not been so short that nothing at all appears. If it has been exposed too long a time, the contrasts will be destroyed by the darkening of the plate where it should remain clear. A properly exposed negative is one which, having been exposed with the ultimate picture and the possibilities of the developer in mind, shows, when developed, dark places of sufficient opacity to insure the necessary high lights of the picture, and sufficient transparency at other points to insure the passage of light in printing the dark parts of the print or "positive."

As I have suggested, the action of the developer, and the particular developer to be used, are calculated, or should be calculated, in making the exposure. If selection and arrangement require artistic judgment, the determination of the length of exposure is the severest test of scientific judgment.

But although the lighting and the length of the exposure determine to a great extent the fate

not so! has since been proven false.

of the negative, much may be done in the development to remedy errors in the exposure, unless these errors be too grave. Every photographer seeks to make the exposure conform to the powers of his developer and the requirements of the print he wishes to make; but if from accident or the impossibility of giving longer exposure at the time the plate is exposed, the plate has not received as strong an impression as it should have had, the operator seeks to coax out the image by the modification of the developing formula in some manner. In general development is continued longer for under-exposure. Modification again becomes necessary in case the light impression upon the plate has been excessive. The change in the elements of the developer is a change differing from that made necessary by the other difficulty, but in the instance of either defect in the exposure — too much or too little — the development is likely to occupy a longer time than if the exposure had been in full harmony with the developer.

The theory by which a negative is produced is that the chemical action shall darken the parts affected by the light. If chemicals were used to darken the parts unaffected by the light, it will be seen that a positive would be produced. In dry-plate photography the developer used is what is known as an alkaline developer, because only an alkaline chemical agent will "reduce" the silver.

There are many of these alkaline developers,

some of which we shall consider a little farther on. Whichever is used, the image is brought out to the best possible advantage, and is then placed in a "fixing bath," to which I shall hereafter give the familiar name of the "fixer." The office of the fixer is to remove from the plate the silver salts that have not been acted on by the light and the developer and thus to prevent their being further influenced by light.

After the fixing the plate is thoroughly washed, in running water preferably, and dried. It is then a completed negative, save for such "retouching" as it may receive.

Retouching, so-called, is the correction, by the use of pencil or brush and coloring matter, of such defects, artistic or physical, as may be corrected in this way. Most photographic portraits as sent out from the mercantile photographer's gallery are carefully retouched in every detail when the photographer thinks he can effect an improvement.

The negative thus produced, after being exposed to the light in one dark chamber, is subjected to the action of the developer in another dark chamber — the photographer's "dark-room," at which we shall look for a moment before going more deeply into the matter of developing the image.

CHAPTER XIII.

THE DARK-ROOM.

If the amateur photographer seldom is able to enjoy the luxury of a skylight operating-room, a dark-room is not so rare. The dark-room may be small, and generally is small. The many amateurs who have quarters that are wholly devoted to the chemical part of photography have the opportunity to make their work easy or difficult in those many respects where cleanliness, order, and exactness affect the result. Those who are unable to secure a "den" which may be devoted to photography are under a still greater necessity to be orderly and precise in the arrangement of their work.

A room given up to developing should, of course, have running water. In a city house running water may sometimes be easily placed in a room where there is no such convenience; but under certain sanitary regulations and the necessity of a vent pipe to the roof from the trap of the waste pipe, this often may necessitate much plumbing. In a country house a pipe from a rain-water tank often solves the problem.

However, under any circumstances a shelf tank may always be placed in the room where the developing is to be done. A tap from this may lead to the developing sink.

The developing sink should if possible be long enough to have two taps, with one waste pipe. One tap does service during the development in mixing, diluting, rinsing the plate, etc. The other may be supplied with a tube leading to the washing box. The sink should be fitted with a wooden tray made of narrow strips of wood extending the full length, and resting on the ends of the sink if desired, and bound together by two underneath cross-strips. This tray frame holds the developing trays during the development, and drains off all that may be spilled or spattered. The nose of the tap should be high enough above this tray to permit the standing of a tall graduate or a quart bottle underneath. If there is a heavy pressure of water a cloth pocket may be tied to the tap. This will take the sprightliness out of the stream; and while it will permit the plate in the developing tray to be pushed under it for washing, the pocket may be slipped into the top of a graduate or bottle.

The working light of the dark-room must be non-actinic, and for this reason such light as can be used is transmitted through ruby or ruby and orange glass. This light may be furnished by gas, by an ordinary oil lamp placed outside of a

red glass partition window, or by a special developing lantern. The most convenient form of light may be had when the developing-room is partitioned off from a large apartment. In this case a square window is cut on a level with the top of the sink, and just back of the place where the tray will rest during development. The window may be made of two thicknesses of ruby glass with a sheet of orange glass between, or it may be made with one sheet of ruby and one of orange, according to the thickness of the glass and the amount of light in the outer room during the day. Some photographers have a double window; others have the window frames made so that any combination of glass may be slid into place; many more have a shade curtain of red material that may be rolled down like a window shade at the outset of the developing when the fresh plate is brought into the red light. This shade or something equivalent to it is quite necessary, as the plate must be guarded from even strong ruby light until it has been for a minute or two in the developer.

The window, which should be hinged at the top and open upward out of the way, and have a hook to hold it up when daylight or full white light is wanted, should have a shelf outside if an oil lamp is used, or a gas jet if this is to be had. The great advantage of the gas is that the regulating key can be placed on the inner side of the partition and the flame so raised and lowered that

no shade or other precautionary arrangement will be needed at the window. I have known ingenious amateurs to arrange levers, wheels, etc., for regulating a lamp flame from within the partition.

An economy in light may be practiced by fixing to the partition on the outside of the window a semicircular reflecting screen of tin or cardboard, inclosing the light.

If there is no partition which may be used in this way, it may not be easy to have the light back of the sink. In this case it may be placed at one end of the sink. The height of luxury is to have a movable incandescent electric light in ruby bulb, with red cloth screen, which may be moved from place to place. However, a broad window, backed by a reflector, has the advantage of permitting the operator to examine a large plate with readiness by holding it up between the eyes and the broad field of light.

Somewhat the same effect in a portable light may be had from a box about 12 inches wide, about the same depth, and 15 or 18 inches high. Taking an ordinary box and standing it on end, the open side upon which the cover has been may be grooved for two thicknesses at least of non-actinic glass, say a deep ruby and an orange. A part of one side may be hinged to admit of putting in and taking out a small lamp, and the top must be ventilated by some method that will not throw out direct rays of the lamplight.

The ruby lanterns sold in the shops are to be looked upon with great suspicion. Good lanterns are sold, but in many of the cheaper varieties the glass is often of a kind to result in "fogging" the plates during developing. A careful operator always gives himself the benefit of the doubt by having a light unnecessarily dim rather than one that endangers his plate. A convenient safety screen for a small lantern may be made of yellow paper in the form of a Chinese lantern. This may readily be lifted out of the way after the development is well started.

To test the safety of a light, place an unexposed plate in a holder. Draw the slide covering the plate half way out, then place the holder about a foot from the light, so that the exposed part of the plate may receive the full force of the rays. At the end of ten minutes the immersion of the plate in the developer will reveal the extent to which the light has affected the exposed part of the plate. Even a safe light will influence a highly sensitive plate under these circumstances; but if the impression is pronounced, the light is too strong to be used while transferring the plate to the developer and during the early stages of developing.

In a well-appointed dark-room a broad shelf should extend from each side of the sink; in fact, on three sides of the room, if possible, at about the level of an ordinary table. A few deep drawers

are useful, and a dark box or closet is valuable as a means of keeping plates that have been removed from holders or magazine before developing.

Just over the sink, or convenient to the right or left hand of the operator, should be a shelf for the chemicals used in developing, fixing, etc., not to mention other processes, such as toning prints, which we shall consider later on. In fact, there should be plenty of shelf room over the sink and table shelf. The chemical solutions should be kept in wide-necked stopper-bottles, all carefully rinsed with hot water before being drained for use. Each of these bottles should be carefully labeled, the label being printed in large, conspicuous letters such as may easily be read in a dim light. If the bottles are not all of the same size, they will be more easily recognized, and there will be less danger of confusion, a distinctive shape being a great help to the label. Moreover, they should each stand always in the same spot.

The chemicals not in solution, the unmixed ingredients, liquid and elsewise, should be kept on shelves convenient to operations at the sink. If there is a gas jet in the room, have the chemicals ranged where the light will fall upon them. The glass graduates, always scrupulously clean, should be kept in a rack, perhaps one cut to hold them by the foot-piece, head down. A very simple weighing apparatus will be sufficient for ordinary purposes, but one having a good set of weights

and broad and well-hung receptacles is always worth having if possible.

What is said here of a room used as a dark room will apply very largely to a room occupied incidentally for photography. In city houses a bathroom is very often used for photographic purposes. In such a case, or in any where the room is not private to the photographer, the chemicals should be kept under lock and key. Many deadly poisons being used in various processes, there never should be any danger that a person ignorant of their character might come in contact with them; and not only is there danger from ignorant or careless handling, but from special mistakes. It thus is absolutely necessary that the photographer's chemical stock be well guarded, and that for his own good the photographer look well to his labels. Label everything, and label in large, clear letters.

In small quarters, a portable table may sometimes be arranged by hanging a board to wainscoting or sink. Other folding appliances or arrangements, by which shelves are set into grooves, will add to the impromptu conveniences. The advantage of having these matters methodically arranged, so that little time is lost either in preparing for work or in clearing up after the work is done, is that the home photographer will not be frightened off, or discouraged from using a half hour of spare time, by the

thought that much time must be given up to the merely preliminary "fussing," or to the after-work.

As I have suggested, everything about a dark room should be kept scrupulously clean. It is necessary (for the beginner at least) to do as little guessing as possible, and in the same degree it is necessary for everything to be kept so clean that the operator shall never be in any doubt as to the freedom of each chemical element from contamination by any other element.

A good general rule toward cleanliness is to arrange matters so that there may be as little as possible of dust accumulation. To this end, everything that may be kept in tight table drawers or closets should be so guarded. The bottles containing the developing solutions may be stored on a boxed shelf, with a front lid hinged at the top, which when opened and hooked reveals the line of bottles free of dust. If this cannot be done, wipe the necks of the bottles carefully before pouring from them.

Upon a convenient nail in the dark room should hang a broad camel's-hair brush, to be used in dusting off plates before they are placed in holders. Specks of dust on the plate, if not disturbed, will result in minute white spots in the negative, which are sometimes, though misleadingly, called "pin-holes." The same brush (itself kept out of the dust) should be used after the exposure when the

plate is taken out and about to be placed in the developer. Near the tap may hang another camel's-hair brush, to be used in clearing the surface of the plate after the developing and before placing in the fixer. Sometimes sedimentary deposits form on the plate during the development, not to mention dust particles falling in the room itself, and the ordinary washing under the tap may not sufficiently dislodge these, unless the brush is used while the water of the tap is running over the plate.

The fixing tray — or box, if a grooved receptacle is used — should be sufficiently far from the developing tray to prevent the possibility of any spattering of "hypo" getting into the developer.

If a regular washing-box is used, the running water will enter, and be drained from it by tubes. The amateur may readily construct a washing-box, by taking, for instance, a tin cracker-box, and fixing, or having a tinsmith fix, a drain tap at the bottom. If running water can be had, a rubber tube may be lowered into the box from the top, and extend to a point somewhere below the middle, perhaps, and another tube will carry away the water from the drain opening to the sink. If it is not convenient to have running water enter the box, the drain opening may be corked, and the water occasionally drained off. A wooden frame may be constructed to snugly fit this box, with

side grooves, permitting the plates to stand on end about a quarter of an inch apart, and keeping them about an inch above the bottom.

The difficulty with a tin box is that it will rust, if not scrupulously dried after use. Zinc is better material, if such a box can be secured. Wooden boxes are often used, without the metal outer box. The advantage of an interior frame, whether of metal or wood, is that after the plates have been sufficiently washed, they may be lifted out in the frame, and so left to dry, without danger of scratching or falling.

Developing trays should be shallow, unless they are larger than 8 × 10 inches. There should be one tray at least for the smallest plates that are used; say 4 × 5 inch plates. A tray just large enough for the plate used has the advantage of not wasting developer. When the operator has the necessary experience and is sure of himself and his plates, he may develop four or six plates in one tray at one time if he chooses.

The fixing tray and trays afterward to be mentioned in the instructions for printing, etc., may be deep trays. The fixing trays should be large enough to hold at least two plates of the size of those that are being developed. Better than this is to have a tray capable of holding at least four plates.

The dark-room door should have a convenient inside catch which should *never be unfastened* at

any time when white light would injure the plate or plates that may be exposed. Never trust to the caution of those who may have the privilege of paying you a visit. They may think your plates are not exposed at the time, or that you are "not doing anything in particular," and the safest way is the best. If you wish to admit any one during the development, or to leave the room yourself for a moment, place a cover over the developing dish. After the plate has been a minute or more in the fixer, there is no longer special need to keep the door closed. Naturally, if only a faint white light is admitted by opening the entrance door, there is much less need of being cautious than there would be if a strong light might enter. Lamp or gas light from a neighboring room will not be bright enough to be worth guarding against, even while the plate is in the developer, if the door is only opened for a moment.

Thus, in making the dark-room sufficiently dark it is well to consider the *kind* of light that may enter. Daylight must be carefully kept out; and the photographer must remember that a pinhole admitting direct light is more dangerous than a larger opening admitting fainter reflected light. To get the room dark enough in the daytime, it may be necessary to tack cloth or wooden strips on door or window cracks; but at night all of these difficulties are much simplified. An ordi-

nary thick shade will be enough at the window, unless the window opens on an electric-lighted street, and the lamp or gas light creeping under the door will not do any damage unless the plates are unduly exposed to it.

The temperature of the dark-room and its chemical contents is of much importance. Sensitive films must not be overheated or they will frill, and in summer the developer and fixer must be cool; but neither must the dark-room be cold. When solutions fall below a certain point in temperature they work poorly, and if very cold go wrong altogether. This point is variously fixed, but it may be safely set down that solutions should be kept in a temperature agreeable to the body, or perhaps slightly below this; roughly speaking, in a room warmed to between 60 and 65 degrees. If the room has been much colder than this, care should be taken to slightly warm the solutions by placing them in a warmer place for some time before developing begins.

CHAPTER XIV.

DEVELOPING THE IMAGE.

Every package of dry plates is accompanied by a printed formula for developing and fixing, and generally with instructions as to the use of the ingredients in case the plate is known to have had, or may be found to have had, too little or too much exposure. The maker of the plates may say that "any good formula" will develop his plates, but he recommends the formula he offers with them as most likely to give the best results.

Perhaps the plate-maker is right in thinking that the formula he gives is best for his plates. I say "perhaps" because the plate-maker may be mistaken; he may not have given a proper trial to all other developers. But it is true that a "good formula" will develop about equally well all ordinary kinds of dry plates.

Whether the amateur begins with the formula contained in the first package of plates he buys, or begins with some other, he should use the chosen developer carefully and accurately, trying it under different conditions, making special experiments if necessary. The photographer who

changes his developers frequently is always in uncertainty, and is in danger of becoming a mere dabbler who finds out a good many things that do not do him any good, misjudges developers because he has not given them a proper test, and produces very few pictures.

Stick closely to one developer until you have *proved* that another is better. The proving is simple enough. Having prepared your tried developer, prepare a sufficient quantity of the developer you wish to test, or of the modification in the same developer, following carefully every instruction of the formula. Then expose a plate in the camera upon some subject that will give about the same density of image upon all parts of the plate. Having removed the plate in the dark-room, break it in half, put one piece in one tray and the other piece in another. By developing the two pieces at one time with the two developers, it will be easy to judge of the relative qualities. Each developer, however, must be given its own time. One may take a little longer than the other; and while a reasonably quick developer is always welcome, the final test is in the appearance of the negative when the development is finished. In fact, the test, while simple in method, requires care and judgment to make it really a true one.

Unless the photographer is certain that the developer with which he has experimented is actually better than his tried developer, he will be

wise not to "change horses in crossing stream." Prepared developers, in one and in two solutions, are sold at photographic supply stores. These are often useful, as when the photographer is traveling; but the amateur is generally better off when he knows the ingredients he is using, their proportion, and their meaning.

The two forms of developer which have been longest in use for the developing of dry plates are the oxalate of iron, or ferrous oxalate developer, and that containing pyrogallol, or pyrogallic acid. These are familiarly known as the "iron" developer and the "pyro" developer.

THE "IRON" DEVELOPER.

The iron developer is always excellent for beginners, it being simple in form, and not disagreeable to handle. I shall give this developer in proportions which may be changed somewhat as the photographer learns to adapt his developer to special requirements in his work.

Oxalate of Potash. Take a quart bottle and dissolve in it with 30 ounces of hot water 8 ounces of neutral oxalate of potash. This is the "stock" bottle of the potash, and should be labeled "stock potash" or otherwise distinctly marked. When the potash is completely dissolved, some of the solution should be filtered into a smaller bottle for use in developing. A pint bottle may be filled for this purpose. Use a glass, or other safe filter.

Filtering paper may be had at the druggist's, where it will be easy to get instructions as to folding it. The pint (or small) bottle when filled with the filtered solution may be labeled No. 1.

Sulphate of Iron. For the sulphate of iron stock solution, a pint bottle will be sufficient. Dissolve 10 ounces of the iron in 15 ounces of water, adding one drop of sulphuric acid for each ounce of water used, and filter 5 or 6 ounces of this into a small bottle to be labeled No. 2.

Oxalic Acid. Dissolve in a third stock bottle 3 ounces of oxalic acid in 10 ounces of water. Filter a few ounces into a bottle to be labeled No. 3.

We now have the ingredients of the developer ready for use. Supposing that we are to develop a plate 4×5 inches in size in a tray of the same size (that is, made to receive a 4×5 inch plate) we shall take a graduate and pour into it the three elements in the following order and in following proportions : —

No. 1	$2\frac{1}{2}$ ounces.
No. 2	$\frac{1}{2}$ ounce.
No. 3	2 drams.

If the potash is added to the iron instead of the iron to the potash, as in the order given here, the iron will precipitate, an accident which may be detected by the clouding of the liquid. In such a case the mixture is rendered useless. If this precipitation should ever occur while the plate is in the developer, the plate should at once be re-

moved and washed, or it will be in grave danger of ruin. To avoid precipitation of the iron never use a larger proportion of iron to potash than 1 to 4.

Having the developer thus mixed in the graduate, remove from the plate-holder or plate closet the plate to be developed, and place it film upward in the tray. Then flow the developer over the surface, emptying the graduate glass, or so much of its contents as may be required.

If the plate has been properly exposed, the high lights of the image should begin to be discernible in about thirty seconds, unless the developer is too cold. After the high lights the detail of the image slowly appears, the general surface of the plate growing dark. If the image is a landscape, the dark effect over the plate will be deeper than if the image is that of an interior in which there is no atmosphere.

It is impossible to describe in print the condition of the negative at the time it should be removed from the developer. Every beginner should, if possible, watch the operation of developing before attempting it himself; but personal experience will be necessary in any case. In general it may be said that when the principal black parts of the negative (the high lights of the picture) show with some distinctness on the back of the plate when it is turned for that inspection, the image has been sufficiently brought out. The

A NEGATIVE THAT EXPANDED

Showing the result of an attempt to dry in the sun a negative from a charming subject

safest judgment, by holding the negative between the eye and the light, will be possible after a little experience.

The description just given is that of developing a properly exposed plate, but the chances that the beginner has exposed his plate to some degree improperly are very great. If the image does not appear on the plate at the end of two or three minutes, the exposure has been insufficient, and two drams more of No. 2 may be added. The result may be that only the brightest parts of the subject will appear in the black image of the negative, but the developing should proceed as long as the image continues to gain in detail or until the unexposed parts of the plate show a considerable darkening.

If, on the other hand, the image should begin to appear very soon, and the whole plate to darken within a minute, the negative should be removed quickly from the developer and washed (by letting water run over the surface) under the tap. Then add to the developer one ounce of No. 1 with one ounce of water and thirty minims of a restraining solution.

Restraining Solution.

The "restrainer," which should be kept in a bottle so marked, may be made in this way:

Bromide of potassium . . .	$\frac{1}{2}$ ounce.
Water	10 ounces.

The action of the bromide is to make the development of the image proceed less quickly and to prevent to a certain extent the "fogging" of the plate in case the exposure has been excessive. If the exposure has been too great, nothing can save the plate.

"Accelerators" are sometimes used to do the opposite of what is accomplished by the bromide—hasten the developing when the exposure has been insufficient. A few drops of a weak solution of hyposulphite of soda are sometimes taken for this purpose, but the use of hyposulphite is not recommended. If the image does not appear with the developer as described for under-exposure, little can be done for it.

As the photographer gains experience he will find many ways of varying the simple iron developer formula, if he wishes to adopt this. The iron developer is used also in two solutions, and sometimes in one.

When the plate is taken from the developer it should be carefully washed, brushed, and rinsed on both sides, so that it becomes as free as possible from traces of the developer. It is then ready for fixing.

Fixing Solution.

To make the fixing bath, take

Hyposulphite of soda . . .	5 ounces.
Chrome alum	1 ounce.
Water	1 quart.

The alum, which will give the bath a greenish color, tends to harden the film, and is especially necessary in warm weather when "frilling" is liable to occur at any time. Many photographers use an alum bath after the first washing and before fixing; and in extremely hot weather, when the plates show signs of frilling at the edges before the development is finished, it is wise to have a strong alum bath in which to place the plate for one or two minutes after a rinsing under the tap, even if the fixing bath itself contains alum.

After it has lain in the fixing bath for a few minutes, the milky color visible from the back of the plate will begin to disappear and the image will be more distinctly visible when the plate is held between the eye and the light. The plate should remain in the fixer for some minutes after the film has cleared in this way — perhaps fifteen minutes altogether. In raising the plate from the fixer to examine or remove it, be careful not to spatter the hypo, particularly if the developing dish is near. Careless sprinklings of hypo will make the dark-room damp and unpleasant.

After the fixing, the plate must be entirely freed of the hypo that saturates the film. If the hypo is not thoroughly washed out, the plate after a time will show a staining and crystallization that will mean that it is ruined beyond repair. Be particular, therefore, to give the plate a thorough soaking in several changes of water

for at least an hour, or if there is running water, in a washing-box or on a washing-tray (placed at an angle so that the water will run steadily over the surface of the plate) for half an hour.

The plates should be dried, after this final washing, in the rack lifted from the washing-box, in a special rack arranged for the purpose, or drained in some position in which they will be as nearly upright as possible. If they are placed upright on a shelf or ledge, the face should be turned inward. The drying place should be dry, not warmer than the ordinary temperature of the dark-room, and as free as possible from flying particles of dust.

THE "PYRO" DEVELOPER.

The pyro developer is a more powerful developer than the ferrous oxalate. Thus in cases of under-exposure it is more likely to accomplish desirable results. In other respects it "works" differently from the iron. It makes a crisper or more brilliant negative. But this is not always a desirable quality, as compared with the soft effects produced by iron, in portraits for instance. Moreover, pyro stains the fingers in a disagreeable way, unless lifting forks or rubber gloves are used. If the iron developer is suitable for the beginner (it is still a favorite developer with many distinguished photographers), pyro is a developer for the experienced hand.

How much more complicated the pyro developer is than the ferrous oxalate, may be judged from this formula by Cramer:—

No. 1. *Alkaline Solution.*

Water	30 ounces.
Carbonate of sodium crystals (sal soda)	$1\frac{1}{4}$ ounces.
Sulphite of sodium crystals	2 to 3 ounces.
(For winter use, 2 ounces of sulphite; for summer 3 ounces.)	

No. 2. *Pyro Solution.*

Distilled or pure ice water .	3 ounces.
Sulphuric acid	7 minims.
Sulphite of sodium crystals	30 grains.
Pyrogallic acid	$\frac{1}{2}$ ounce.

To develop a properly exposed plate, this developer should be made up as follows:—

In winter,	No. 1	1 ounce.
	No. 2	1 dram.
	Water (tepid)	2 to 4 ounces.
In summer,	No. 1	1 ounce.
	No. 2	1 dram.
	Water (cold)	4 to 8 ounces.

The word "tepid" here used must not be understood as meaning distinctly warm water. Water

that has stood for a time in a warm room will be sufficiently tepid; that is, it will have "the chill off."

When there is any chance of over-exposure, and particularly in the summer-time, 30 minims of the bromide or restraining solution already described should be added to this developer. If the plate shows unmistakable signs of fogging from over-exposure, double the amount of the restrainer — a full dram.

If the image appears so slowly as to leave no doubt that the plate was not exposed long enough, the full quantity of water should be used. This will prolong the development. As a further aid to the bringing out of the image, a fresh developer may be made up with half the quantity of pyro (No. 2) and the full quantity of the alkaline solution (No. 1). To do this the developer should be kept very cool, or the plate may fog. Where brilliant contrasts are desired (as in copying line drawings), the quantity of pyro may be increased beyond the proportion given in the formula.

I shall here give a few other formulas for developing, in the order in which they have come into use.

THE "HYDROCHINON" DEVELOPER.

Hydrochinon, hydroquinone, or quinol, is a substance long known to chemists, but only re-

cently adopted as a photographic agent. It is now accepted among the standard developers. In operation it is slower than pyro, but is much like pyro in its results.

The following formula is simple and excellent:

No. 1. *Hydrochinon Solution.*

Sulphite of soda	480 grains.
Hydrochinon	96 grains.
Water	8 ounces.

No. 2. *Soda Solution.*

Carbonate of soda . . .	480 grains.
Water	8 ounces.

For ordinary use make up this developer as follows:—

No. 1	8 drams.
No. 2	4 drams.
Water	4 ounces.

Bromide should be added to this developer under the same circumstances as in pyro. If it is not probable that the plate has had too much exposure, omit the bromide. Unlike pyro, hydrochinon may be used repeatedly, although it will work more densely — giving stronger contrasts — as it proceeds. It is thus better to use fresh developer for an under-exposed plate; but unless the plate is known to be over-exposed, the operator should give to himself the benefit of the doubt by begin-

ning the developing with old developer, of which I shall speak in a moment.

THE "EIKONOGEN" DEVELOPER.

This developer, to which photographers like to give the pet name of "Eiko," is one of the later favorites. It is used both in one and in two solutions, and produces a very rich black in the negative image. Here is a single solution formula:—

Sulphite of sodium crystals .	2 ounces.
Carbonate of potassium . .	1 ounce.
Eikonogen	½ ounce.
Water (boiling)	20 ounces.

This is the stock solution. To develop take three ounces or more, as may be required to cover the plate.

A two-solution formula for eikonogen — probably better than the other — is made up in this way:—

No. 1. *Eikonogen Solution.*

Sulphite of sodium crystals .	2 ounces.
Eikonogen	½ ounce.
Water	30 ounces.

Shake until the eikonogen is dissolved.

No. 2. *Soda Solution.*

Carbonate of sodium crystals	1½ ounces.
Water	10 ounces.

For developing make up as follows: —

No. 1	3 ounces.
No. 2	1 ounce.

For fixing negatives developed with eikonogen, a special form of fixing bath is generally recommended. This formula has been given by Cramer: —

Dissolve 16 ounces of hyposulphite of soda in 3 pints of water.

Dissolve in a separate pint of water 2 ounces of sulphite of sodium crystals, adding $\frac{1}{4}$ of an ounce of sulphuric acid.

After the ingredients are completely dissolved, pour the latter solution into the former, and allow it to settle before using.

I shall not undertake to give any further formulas in this chapter. On later pages of this book will be found other formulas which the amateur may wish to test.

It will only be necessary here to say a few words about the use of developers in general. The dark-room should be supplied with a pint bottle marked "Old Developer." ("Old dev" on one of my bottles has always seemed mysterious to the uninitiated!) After a developing solution has been used it may be poured off into this bottle. On the next occasion when plates are to be developed this old developer may be used to start the plate, especially where there is any un-

certainty as to whether the plate may not have been over-exposed.

Iron and pyro developers, in particular, work much more slowly after one use; and if the plate, instead of being over-exposed, should be found to have been under-exposed, the old developer should be rinsed off before the plate is placed in the fresh developer, for the reason that in such a case the action of the old developer is like that of a restrainer. The old developer is thrown away after the second use, and the fresh developer afterward applied becomes the old or used developer for the next operation.

The substitution of "films" for plates as a backing for the sensitive surface need make little difference in developing, although special formulas are sometimes advocated. As films do not lie perfectly flat in the tray when dry, it is necessary to see that they are at once completely covered by the developer. Films, like glass plates, may be developed face downwards if care be taken to support the rim in some way so that the face is one eighth of an inch or more from the bottom of the dish.

INTENSIFYING.

Negatives which, after development, are found to be objectionably weak may be "intensified" if they have been thoroughly washed after fixing. The intensifier most in use has been bichloride of mercury and ammonia.

After a thorough washing the negative is flooded with a solution of this kind:—

Bichloride of mercury . .	10 grains.
Chloride of ammonia . .	10 grains.
Water	1 ounce.

This whitens the image. The plate is then washed well and immersed in a darkening solution made up of one part of ammonia to eight or nine parts of water.

CHAPTER XV.

SUN PRINTING FROM THE NEGATIVE.

THE making of the final print is one of the most enticing operations in photography, since it gives at last the product toward whose perfection all the other plans and processes have been directed. At last we are to see things right side up and in their natural light and shade.

At the same time, the printing process is one that brings up many trials and disappointments, especially to those hurry-scurry people who were born without the useful ability to take pains. Above all things, even above exactness, the printing process demands cleanliness. Without cleanliness the chances of a satisfactory result are extremely meagre.

The ordinary sun printing process may be divided into five departments, thus: —

1. Silvering the paper.
2. Printing.
3. Toning the print.
4. Fixing the print.
5. Mounting the print.

Each of these departments includes various

minor operations. The process of "sensitizing" the albumenized paper with nitrate of silver had better be left in the hands of the mercantile photographer, providing, of course, the professional photographer is accessible enough to make this more convenient. Many amateurs silver their own paper, and their grasp of the whole field of operation gives them a certain pleasant independence, not to mention the advantage of entirely fresh material.

If the amateur has plenty of time or lives at a point remote from any photographer who is willing to silver a sheet for him, the silvering process should be mastered, as it may with little difficulty. But nitrate of silver on the hands promptly turns dark, as we have seen, when exposed to the light; and for busy people who must catch the sunlight when they can, the temptation to run into a photographer's and get a silvered sheet is hard to resist. The mercantile photographer, silvering a full sheet at a time, and going through the operation frequently, will have paper that is freer from blemishes (and a spot of the silver solution on the back of the paper ruins that spot) than the amateur's product is likely to be. Moreover, "ready-sensitized" albumen paper is sold by dealers. This is not so good as paper freshly sensitized and used immediately after the silvering and drying, though it is serviceable enough for many purposes. For a silvered sheet bought

at the photographer's, cutting into from fifteen to twenty pieces for small prints, twenty-five cents is a fair price.

After it has been silvered and fumed with ammonia, the paper is sensitive to the action of light, and must be kept in a dark place (such as a table drawer) near the printing-quarters. In a shaded place the light acts so slowly upon the paper that there is no occasion for great precaution against the effect of light.

If possible have a preserving can, made air-tight and containing (between a true and a false bottom) the chemical preservative now sold. By this means prints made at intervals of several days may be kept until such time as the amateur has opportunity to go on with the toning. In very warm weather silvered albumen paper will scarcely remain in good condition for twelve hours without such a precaution. In cold weather it will keep without the use of preservative several days, although it produces the best prints when fresh.

PRINTING.

The best place for printing is one that gives unobstructed sunlight, and that offers opportunity also for printing away from direct rays of the sun. A great convenience is a broad shelf constructed on the outside of a window on a level with the outer sill. When the weather is very cold it is hard to do good printing with the negative ex-

posed to the open air. There are two ways to avoid this difficulty. One is to cover the face of the frame with a sheet of thin white paper; "onion-skin" paper or fine tissue is desirable. The sunlight falling steadily on this paper will warm the air between it and the glass. The other way is to print inside the window. In this case the printer must see to it that blemishes in the window glass do not print themselves through the negative upon the paper. If the glass is not French plate, it is best, when printing inside the window, to cover the printing frame with the tissue or a piece of ground glass. When tissue or thin paper is, for this purpose, placed over the frame, it should be stretched so as not to fall against the negative, else the grain will be printed.

A "thick" negative, or one strong in contrasts, should be printed in direct sunlight. A "thin" negative should be printed slowly, either under two thicknesses of tissue paper or in the shade out of the direct rays of the sun. Many photographers prefer to print in the shade all negatives that do not for some reason — as in "vignetting" — require to be printed under tissue or ground glass. The time occupied is longer, but the results are richer and more brilliant.

As the print should be trimmed before the "toning," it is well to trim it in the first place, before printing. If there is any doubt, however,

as to how much of the negative it is desirable to include in the print, the trimming should be left until after the printing.

"Vignetting" is the name given to that variety of printing by which the image is made to gradually fade at the edges until it disappears in the white of the paper. The usual forms of the vignette are the oval and the egg shape. It is sometimes used in landscapes and often in figure subjects, but generally in portraits. In portraits both the oval and the egg shape are used, the latter usually in cases where the bust, as well as the head, is included.

To use a printing frame for vignetting, it may be supplied with one of the contrivances sold for the purpose, or it may be prepared in this way: Tack a frame of wood about a quarter of an inch high around the face of the frame. Take a piece of pasteboard and trim it to the size of the outer edge of the frame. Pencil on this pasteboard a rough outline of the head and shoulders of the portrait at the point corresponding to their position when pasteboard and negative are in place. Now cut in the pasteboard an opening as suggested in Fig. 19. A piece of tissue paper (the onion-skin always preferred) is then placed over the pasteboard and gummed on at the outer edges. The light enters freely where the opening is complete, and gradually diminishes to the edges, the intervening paper preventing the lines of the open-

ing from marking themselves in the print. The pasteboard may be held on the printing frame with elastic bands, by an outer wooden or metal frame, by folding down a large piece of cardboard so that it resembles a box cover, or by a flange

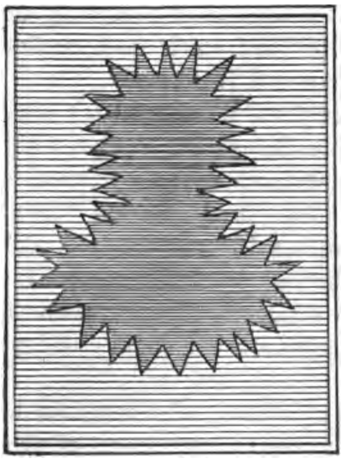


FIG. 19.

fitted to the printing frame and a snugly-fitting wire binding piece. The whole contrivance should face the sun at a right angle corresponding to the height of the sun at the time of printing.

To vignette successfully, a portrait should have a light background, and should be on a plate large enough to permit an easy gradation in the image and background. Unless there is a light,

unfigured background it is seldom advisable to try vignetting. Artistic effects are by no means confined to this familiar method. In fact, some of the most artistic effects in photography, as in any other kind of portraiture, are had by the use of dark backgrounds or backgrounds graded from one side to the other, and producing the brilliant effects of light and shade such as delighted the soul of the revered Rembrandt.

But all such rules for printing, since they belong to the realm of art, are not rigid but variable. Do not hesitate to try original effects; do not be too eager to try "effects" at all; and do not be discouraged by the unappreciative remarks of those who have become accustomed to the formal and so often stilted work which the mercantile photographer is frequently obliged to turn out.

If the development of a negative depends for its success upon the correctness of the exposure, the printing depends for its success upon the qualities of the negative. A weak negative, one in which the contrasts are not strong, cannot be made to yield a strong print, although there is considerable opportunity for the display of skill in the printing process. Parts of the plate may be screened; the back of the plate may be treated with washes of water-color, or covered with tissue on which a pencil or brush has been used to produce a shading that will retard the action of light

at points where this is desirable. In these cases the printing should be done at a spot not visited by the direct rays of the sun.

The point at which to stop the printing depends upon the character of the negative. If the negative is weak, it will be impossible to get a rich, deep color in the shadow parts of the picture. If there are very dense parts to the negative containing any detail that it is necessary to bring out, the shadow parts may be greatly overprinted before this detail is impressed upon the paper.

The fact that in silver printing the density of the print is greatly reduced in the fixing, makes it necessary to considerably overprint the image. Thus, after the image looks sufficient when examined in the frame (open the back of the frame cautiously so as not to slide the paper), it is necessary to print for a certain length of time in allowance for what will be lost in the fixing. Just what allowance must be made can only be determined by experience.

As the prints are taken from the printing frames they should be placed in a drawer or dark box until the operator is ready to go ahead with the toning process.

TONING THE PRINT.

The toning should be done by daylight, though not where there is a strong light. If all the prints have been trimmed, they should be immersed in

a dish of clear water. They will crinkle up on first becoming wet, and should be immersed one by one, face downward, until all are floated in the dish. They may then be moved about for perhaps five minutes, when the water, which will have begun to assume a milky color (from the silver salts), should be poured off and the prints rinsed and floated in fresh water. In the third change of water the prints will have ceased to give off the milkiness. They will then be ready for the toning.

The "toning bath," which should be prepared about fifteen or twenty minutes at least before the time when it is to be used, may be made up in a rubber, glass, or porcelain tray — any perfectly clean tray in which there can be no contaminating substance. This receptacle should be large enough to float the cuttings from a single sheet, and as much larger as may be had. The prints from a single sheet may be managed in a tray of 10 × 12 inches, the prints being kept in motion so that the underneath sheets may be brought to the top and the topmost shifted downward.

Fill the toning tray with a quantity of tepid water sufficient to freely float the prints — it will be well to nearly fill the tray unless it is a large one. "Tepid" in this case means warm enough to seem warm to the fingers when they are dipped into the bath. To this bath must be added one grain of chloride of gold for each sheet

of silvered paper; that is, each whole sheet. (If the prints that are to be toned have been cut from a single sheet, one grain of chloride of gold will be sufficient.)

The gold in liquid form comes sometimes with four or more grains to the ounce, sometimes with two, sometimes with one. This should be known in the buying; and if the solution is four grains to the ounce, a quarter of an ounce will be the quantity to be placed in the bath for each whole sheet. The gold solution is generally slightly acid, and the bath, to tone properly, requires to be alkaline. To make it alkaline, add so much of carbonate of soda (common washing soda) as may be necessary. The test may be made with a piece of litmus paper, but probably a small thimbleful of the soda will be a safe quantity; also add to the bath common salt of a quantity equal to that of the soda. When the bath thus prepared has stood for fifteen or twenty minutes, it will be ready to receive the prints.

The prints may now be lifted one by one from the washing dish and placed in the bath. Here they should be kept in motion, so that each print may receive the equal action of the solution. By getting about half the prints started in the toning dish for four or five minutes before lifting in the remainder, it will be possible to compare the changing color of the toned prints with the color of the untoned or partly toned prints.

The action of the gold bath is to give the print — unless the print is thin and weak in consequence of a weak negative — a rich purple-brown color. How quickly this tone will come into the prints will depend upon the temperature of the bath, the quality of the paper, and other circumstances. If the toning is kept up too long, the shadow parts of the prints will lose their brilliancy and become smoky in color. Avoid carrying the toning so far. It will be particularly necessary to watch the weak prints, which will not bear so much toning, and will not take the rich purple color.

As each print reaches the point where it seems to have the richest color it is capable of taking, remove it to another dish of clear water. When all the prints have been toned and rinsed in clear water, they are ready for fixing.

FIXING THE PRINT.

The fixing bath should be made up of a quantity of water about equal to that used in toning. The water should not be too cold, and to each eight ounces should be added one ounce of hyposulphite of soda.

The prints should here, as before, be kept in motion, and should remain in the bath about fifteen minutes. The hypo will diminish the brilliancy of the purple shadows, giving the prints more of a brownish color, but most of this brilliancy returns when the print dries.

TICK-TICK

From a Photograph by Alexander Black

Beautiful "sepia" effects are produced by only slightly toning the print or by omitting the toning and simply fixing the prints. Rich reddish and yellowish prints are thus made, and for certain subjects the effect is very agreeable.

After the fixing the prints should be immersed for five minutes in strongly salted water, which will harden the surface of the albumen. They should then be washed for a number of hours. If the toning has been done toward the close of the afternoon and it is desired to mount the prints in the evening, four hours in running water will be sufficient. But there is no objection to leaving the prints in water over night if mounting in the morning will be more convenient.

A simple method of washing prints is to have a deep rubber tray with perforations in the bottom. This tray is placed in a larger one, and raised slightly by the placing of low blocks of wood or china (such as small butter plates) under each corner. The water may run in and out of the larger tray while the prints, placed in the inner tray, are prevented from floating into danger. If there is no running water the prints should rest in frequent changes of water during five or six hours.

MOUNTING THE PRINT.

The prints should, as I have said, be trimmed before the toning. If this has not been done in

any instance, the print must be dried, trimmed, and wet again for mounting. There are, indeed, methods of mounting dry prints, but the ordinary and easier method is to take them wet from the tray in which they have been washed, and place them face downward in a heap on a sheet of glass, porcelain or rubber. Squeeze out some of the water, then apply the paste to the top print.

The paste is made of starch, boiled to a very stiff jelly, and is applied with a broad brush. The moisture of the print loosens up the stiff paste to the required consistency. Be careful to give sufficient paste to the edges of the print. Then lift one edge of the print with the aid of the point of a pen-knife, and handle the sheet without touching the edges. Place the upper line of the sheet on the mounting card or album leaf, and lower the rest of the print into place. Use a clean sheet of paper (manila will do) in gently pressing out the air from under the print, which does not require to be pressed heavily. If the paste has been properly applied, the print will not curl up at the edges in drying.

When dry the silver print will be improved by burnishing, which gives a finish and durability like that given to a painting by varnish.

In trimming a print do not hesitate to cut away all that is uninteresting or defective. What is left will appear to much greater advantage by this precaution. I mention this especially because

so many photographers seem to have a prejudice in favor of printing all that is found in the negative. If they use an 8×10 inch plate they mourn every quarter inch that is trimmed off a sheet of this size. Often there is only a 4×5 inch picture in an 8×10 inch negative. Do not spoil what is really good by hesitating to make the print smaller.

BLUE PRINTS.

The name "blue prints" is given to the products of another familiar form of sun printing. These have an excellent quality, and are not only useful for making off-hand proofs from negatives, but beautiful as an art medium when carefully made.

The blue print is made on paper coated with citrate of iron and ammonia and red prussiate of potash. It may be bought in packages ready for printing; but unless, at the time of printing, it has been recently made, it will not give satisfactory results.

To make blue paper a simple formula is: —

No. 1. (In stopper-bottle.)

Citrate of iron and ammonia	1 ounce.
Water	4 ounces.

No. 2. (In stopper-bottle.)

Red prussiate of potash . .	1 ounce.
Water	4 ounces.

Keep the bottles containing these solutions in a dark place, and mix equal parts of whatever quantity may be needed to cover the paper; an ounce altogether will probably be sufficient. Apply the mixture rapidly to unglazed paper (having first dampened the sheet) with a brush or sponge, putting on merely sufficient to tint the paper and avoiding streaks. The color is then a pale greenish-yellow. When the paper dries, it is ready for printing.

Print until the shadow parts, after turning a dark blue-green, begin to bronze or bake. Then remove the sheet from the frame and soak it in clear water for ten minutes. A few drops of sulphuric acid in the water will give the print a greenish color. Tannic acid and carbonate of soda baths are used to give brownish tones, and a pretty lilac tone that will not last may be produced by dilute ammonia. There are other methods of "toning" blue prints.

After the blue print has been washed it may be dried and pressed between sheets of blotting paper. In this case the trimming may be left until after the pressing.

There is not space to speak at length of "combination" printing. By this method clouds photographed on separate negatives may be "printed in" a picture with a white sky. The sky space of the print to which the clouds are to be added is covered in the printing so as to leave the clear

paper for the subsequent print. The place of union may be graded by the use of loose cotton —not, of course, in direct sunlight.

Pretty combinations, both in blue and in silver prints, are made by the use of various negatives and mats that keep certain parts of the printing paper clear while other parts are being acted upon. Fern leaves, lace, and other materials are employed in producing background and combination effects.

CHAPTER XVI.

VARIOUS METHODS OF PRINTING.

THE number of methods by which prints may be made from the negative, both with sunlight and with artificial light, has greatly increased in recent years. A few of the more serviceable methods may be described here.

"PLAIN PAPER" PRINTS.

These are sometimes called "salt prints," and are liked by artists because they are unglazed, because they can be used as a basis for ink drawings with "bleaching," and because they are in themselves beautiful when well made from good negatives. Drawing paper of various kinds is effectively used for these prints, which are sometimes made the basis of a water-color painting.

To prepare the paper, the full sheet must be fastened to a board with thumb tacks. Then make up a solution as follows:—

Chloride of ammonium . .	16 grains.
Water	2 ounces.
Gelatine	4 grains.

The gelatine may be placed in cold water, and

the cup or graduate afterward heated by standing in hot water until the gelatine is dissolved. This solution may be applied to the paper in the same manner as the solution for blue prints. After the sheet thus salted is dry, brush the sheet carefully with a solution made up of

Nitrate of silver	60 grains.
Water	1 ounce.

This brushing must be done so as to avoid streakiness, or the printing will not be uniform. The printing, toning, and fixing are the same as in silyer printing.

PLATINUM PRINTS.

For the beautiful platinum print the photographer is indebted to Willis of England and Pizzighelli of Bosnia. The paper may be bought ready sensitized, and most amateur operators will prefer to provide themselves with the material in this way. For the benefit of those who may wish to prepare their own paper a formula may be sketched as follows: —

Suitable paper (that is, of a fine, firm, unglazed surface) is floated for two or three minutes upon a solution containing

Water	20 ounces.
Gelatine	60 grains.
Chrome alum	6 grains.
Aniline blue (powder)	10 to 20 grains.

The gelatine is soaked in the water for from

one half to three quarters of an hour, then warmed by the placing of the vessel containing the solution in a larger dish of heated water. When the gelatine has dissolved, the alum and aniline blue (or whatever elements are used with the gelatine) are added and the whole filtered and cooled. Some operators immerse the sheet in this instead of floating it. In either case beware of air bubbles on the surface of the paper, as these, if remaining, would produce blemishes.

When removed from the solution the paper should be hung up by two corners until dry. Then it should be treated again, hung up by the opposite corners, and dried again. The paper is now ready for sensitizing.

To sensitize prepare the following solutions:—

Ferric Oxalate Solution.

Ferric oxalate	120 grains.
Distilled water	1 ounce.
Oxalic acid	8 grains.

The solution should be kept away from actinic light.

Chloro-Platinite of Potassium Solution.

Chloro-Platinite of Potassium	80 grains.
Distilled water	1 ounce.

From these two solutions make up a third containing 24 drams of the platinite solution, 22 drams of the oxalate solution, and 4 drams of distilled water.

The paper should be coated in weak light. To hold the paper flat it may be fastened by "clips" to a sheet of glass or the corners held in some other satisfactory way. The solution, in a plate or wide dish, should be applied to the paper with a soft pad (such as one of cotton in muslin). A sufficient quantity of the sensitizer is poured into the middle of the sheet, and then spread over the paper by a gentle rubbing with the pad until an even coating has been given to the whole surface. This rubbing should occupy two or three minutes. The paper is now hung up to dry once more. When it is nearly dry — when the wet appearance of the surface has disappeared — the drying may be finished by holding the sheet near a stove or heater. When the sheet is dry enough it will crackle. It must be absolutely dry before the printing.

The printing is done as in the silver and the plain paper processes, but is more difficult to estimate, as much of the image does not appear until the development. Only practice can enable the operator to estimate the proper length of time in printing. The time is short, and care should be taken in examining the progress of the printing not to "fog" the paper.

The developing solution may be made of

Oxalate of potash . . .	130 grains.
Distilled water	1 ounce.

This solution must be heated to a temperature

of about 175° F. The print is placed face downward upon the developer (by *sliding* the paper into position, air bubbles may be avoided) and held there for two or three seconds. The image may be emphasized where it may need deeper tones, by a prolonged contact with the developer at those points, but this special treatment requires considerable practice.

Accompanying the developing solution should be three baths, each containing hydrochloric acid $\frac{1}{4}$ ounce, water 15 ounces. After the development, the print should be immersed in one of these baths for ten minutes, and afterward for the same length of time in each of the others. The print is then washed and dried as in the other processes.

There are a great number of platinum processes, and the operator must undertake to find for himself the advantages of each. Different ingredients give different qualities to the color, density and brilliancy of the print; and the character of the negative, must here, as in other processes, regulate the method of printing.

BROMIDE PRINTS.

This name is given to prints made upon paper coated with bromide of silver in gelatine. In the market it is generally sold in three grades: smooth and thin, smooth and thick, rough (like drawing paper) and thick. For contact prints —

all ordinary prints — the smooth surface is to be preferred.

The paper is extremely sensitive to white light, and is generally printed by oil or gas light, a few seconds only being required for this purpose. As no sign of the image appears until the development, hold the printing frame at a definite distance from the light, and note the precise number of seconds, so as to correct the exposure on the next trial if the first has been at fault. With a full lamp or gas flame a clear negative will require, let us say, fifteen seconds' exposure at a distance of three feet.

The exposure may be made by carrying the printing frame under a cloth from the dark-room to the place near the light; by the opening of a red-glass window in the dark room and admitting the light of a shelf lamp; by the use of an automatic gas-jet regulator in the dark room, or by any other means enabling the operator to regulate the time of the exposure so that he may make necessary corrections.

The development is with the "iron," the hydrochinon, or the eikonogen developers, already described. The "iron" or ferrous oxalate developer was first, and still is most widely, used for developing, but with many variations on the simple formula.

There is this difference between the development of a bromide print and the development of

a negative: When the development has gone far enough, the developer is poured off into the graduate or bottle, and then, *before washing in water* or placing in the fixer, the surface is flowed with a few ounces of a solution made up of

Acetic acid	1 dram.
Water	32 ounces.

Use enough of this to barely cover the paper, and keep the tray in motion so as to wash the surface of the print with the solution. At the end of about a minute pour off the acid solution, and add a few ounces more of the same. A third wash may be used at the expiration of a minute. Then wash the sheet under the tap, turning it over in the tray so as to wash the back also; then put in a fixing solution containing

Hyposulphite of soda . .	1 ounce.
Water	8 ounces.

The print will fix in about five minutes. It should then be washed for thirty or forty minutes.

The greatest cleanliness is necessary in bromide printing if stains are to be avoided. Care is necessary in touching the surface before or during development. Before beginning the development the print should be soaked in water until it is limp. The developer may then be gently flowed over the surface. If the developed print is washed before it has been treated with acetic acid, the surface will be ruined by precipitation of the iron.

For discolorations appearing after the fixing, the print may be immersed in a solution made up of

Sulphuric acid	1 ounce.
Chrome alum	2 ounces.
Water	20 ounces.

After remaining in this solution for a few minutes the print must again be washed for thirty or forty minutes.

In the case of large negatives it is well to experiment, as to the time necessary for the exposure, with a small piece of the paper used on some part of the negative representing its average density.

Bromide prints make the most richly black and white of all prints from the negative. They are not so delicate in quality as platinum prints, nor capable of such variety in tone, but they are a very useful form of print.

Enlargements with bromide paper are described in a later chapter. The mounting of prints made by this process must be done when they are dry, starch paste being used as in the mounting of other prints.

CARBON PRINTS.

The carbon printing process is based on the principle that by the action of light a mixture of gelatine and an alkaline pigment is rendered insoluble in water. Carbon and other pigments are used to bring out an image under the negative.

For sensitizing the prepared paper, or tissue, as it is usually called, the following formula is given: —

Sensitizing Bath.

Bichromate of potash . .	1 ounce.
Liq. ammon. fort. .880 . .	5 drops.
Distilled water	20 ounces.

The tissue is immersed in this sensitizing bath. Two minutes will be a sufficient time in hot weather; in cold weather three minutes is recommended. After drying in a dark, dry place, the paper is printed in the usual way. The time necessary for the exposure must be judged by experiment. A piece of sensitive paper that at once shows the action of light, placed in a corner of the same frame or in an adjacent exposure, — constituting what is called an actinometer, or measurer of light, — will aid in estimating the necessary length of the exposure. As the action of the light on the tissue continues in the dark, the process is complicated somewhat. This fact must be considered in the exposure, especially if the development is not to take place at once.

The exposure to light having made the face of the gelatine insoluble, the development must be from the back. For this purpose the film must be transferred to some support, after the fashion of the "transfer pictures" with which young people delight themselves. But as this would re-

verse the image, — put the left of the picture on the right, — it is necessary either to have printed from a reversed negative or to only temporarily transfer the tissue, replacing it after the development on a permanent support.

There is one advantage of this transferring trouble: when the final transfer to the permanent support is made, it may be to any suitable surface such as porcelain, ivory, stone, shell, wood, or metal, and many beautiful decorative effects are made possible.

For the temporary support preceding the development, a strong, smooth paper is used, the surface being coated with shellac, and the sheet rolled, coating outwards, until it is required for use. That the gelatine tissue may not stick to the support, the shellac surface is coated with a solution containing —

Yellow resin	36 grains.
Yellow wax	12 grains.
Turpentine	2 ounces.

The wax is melted and the resin and turpentine added. This solution is applied to the surface with a tuft of cotton or flannel. When the surface is dry (the drying will take several hours), the support sheet thus prepared, and the tissue which has been exposed and is to be developed, are immersed in water. When the tissue becomes thoroughly limp it is turned, film downwards, over the support surface, and both lifted from the water

together. To make the contact perfect a "squeegee" is used. The two sheets are now placed between blotters for ten minutes, after which they are removed to a water bath heated to about 110° F. Watch the edges of the gelatine sheet, and when the gelatine begins to "run," the paper may be peeled off, leaving the gelatine upon the waxed surface. The gelatine is now washed by a spraying of the hot water, or by the use of a brush or sponge, until all but the insoluble parts bearing the image have been washed away.

When this development is complete, a cold bath sets the gelatine, and a hardening bath follows. The hardening bath may be made of

Powdered alum	1 ounce.
Water	20 ounces.

Its effect is also to remove the yellow tinge of the bichromate salt, and its action may be continued for ten minutes, when the whites of the picture should be clear.

The final support for the picture, whatever it may be, should be prepared to receive the film. Suitable paper, that merely requires soaking in an alum solution containing ½ ounce of powdered alum and 1 pint of water, may be purchased. If the surface is one that must be specially prepared, the coating solution consists of 1 ounce of gelatine in 20 ounces of water, to which, when the gelatine has softened and has been dissolved by heat, is added, a little at a time, 12 grains of

alum dissolved in an ounce of water. The final transfer of the film containing the image is made in the same manner as in the case of the first transfer. If the reversal of the image is not an objection, or if the original image has been produced from a reversed negative, the first transfer may be directly to the permanent surface.

I have merely sketched one method of performing a difficult operation in photography. If after reading this sketch the reader actually wishes to try carbon printing, it will be wise to get fuller information from some book devoted particularly to this form of printing — or do better by watching some competent operator go through the process.

CHAPTER XVII.

TRANSPARENCIES, LANTERN SLIDES, AND ENLARGEMENTS.

It is a delightful circumstance in photography that the negative enables us not only to get a positive of the same size, but to get an enlarged or a reduced positive. Moreover, it is possible to make the positives on glass, thus giving us the always interesting "transparency" and that special form of transparency called a lantern slide, by means of which the image is thrown in any desired size upon a white wall or screen.

TRANSPARENCIES.

A transparency is a print from the negative in which glass takes the place of paper. For several reasons the transparency is more delicate, accurate, and beautiful than the print on paper. It is more delicate because it is made on a finer and firmer surface. It is more accurate because glass does not shrink or expand as paper does. It is more beautiful because the high lights are produced by transmitted light instead of by a dead white surface, and are thus made more brilliant and more suggestive of nature than ordinary prints.

A transparency may be made by placing a sensitive plate in face to face contact with a negative. The plate chosen for this purpose is generally a "slow" grade of dry plate, sufficiently larger than the image to permit of a white border between the edge of the image and the rim of the frame by which the transparency is hung up.

To "mat out" the image, that is, leave the white margin, a large printing frame containing a sheet of clear glass must be used. A piece of pasteboard of the same size as the clear glass is then cut so as to admit in the centre the negative from which the transparency is to be made. A clearly cut opening of the size desired for the image — do not use more of the negative than will make a good picture — is then made in a sheet of thin opaque paper; a black unglazed paper is best. When the opening fits to the desired place over the negative, its outer edges should be trimmed to meet the inner margin of the frame so that it will keep its position. As a precaution, a little paste may be used in attaching the opaque paper to the pasteboard.

A piece of glass the size of the proposed transparency may now be laid in the frame; and when the opening is brought in proper place in the centre, the outer corners may be marked with a pencil or piece of pointed chalk in such manner as may be visible in the ruby light of the dark-room.

The sensitive transparency plate is now placed

face downward in the printing frame, just as the paper has been placed in other forms of printing, and its corners adjusted to the marks. A piece of black paper or felt is laid over this and the frame cover fastened in. The black backing prevents the reflection of light from the white lining of the frame cover, if it has such.

The best light for transparency-making is one that is steady like gas, oil, or incandescent electric light, and that is not too strong. A few seconds only are required. The frame should remain perfectly rigid during the exposure, so that if there is any unevenness in either the negative or the transparency surface, and the developed and undeveloped films are not in absolute contact, there may be no want of sharpness on that account.

The utmost care should be exercised in handling the transparency plates before and during development; for while the negative does not suffer greatly from a slight stain in the corner, the transparency, with its conspicuous margin, is sadly marred by any blemish. A metallic developing fork is a desirable thing in such a case. Have the trays very clean, and the fixing bath fresh and filtered. Be particularly careful about not getting "hypo," if not more than a drop, in the developing tray.

The plate may be developed to good advantage with the "iron" developer. After a thorough fixing, immerse the plate for one or two minutes

in a clearing solution consisting of ½ ounce of sulphuric acid, 1½ ounces of powdered alum, and 20 ounces of water.

With transparencies, great care should also be taken in the washing, which should be so conducted that the film shall not be damaged by sediment or other substance.

Metallic frames are provided for the framing of transparencies. To protect the film and properly transmit the light, a piece of ground glass, or glass coated with an emulsion to give the same effect, is placed on the film side of the positive, the ground or emulsion side in contact with the transparency film. Ground glass with an etched border is made for this use. The border fills the space between the matted picture and the frame, and produces a decorative effect. Unless a picture is strong and brilliant, it is better without the etched border.

Transparencies are also made by the carbon process, and by various other methods which need not be described here.

LANTERN SLIDES.

A lantern slide is a small glass positive, made by contact with a small negative, or by reduction from a large one, and of a size suitable for the stereopticon lantern.

When made by contact it is made on the same principle as the transparency, save that it is

unnecessary to mat out the negative, because an opaque paper mat is used for the slide itself. One of these mats, showing the area of the image that will be included by the slide, may be laid upon the negative in choosing the part that will be used in the picture. A large number of small plate negatives — like the $3\frac{1}{4}$ and $4\frac{1}{4}$ and 4×5 plates — may be reproduced in lantern slides by contact in this way.

Larger negatives, or small negatives such as those I have mentioned, in which everything on the plate must be included, must be reproduced by reduction. For this some apparatus is necessary. If the operator has a copying camera the question of apparatus will be disposed of. If he has two cameras, — one to hold the negative, and the other, with lens front removed, placed to hold the holder with the lantern plate, — the difficulty will not be great. With one camera the simplest process will probably be this: —

Place a table close to the window at which the work may be done, having the long way of the table at a right angle with the window. Construct a box about 12 inches deep, 16 inches wide, and 20 inches long, with the two ends open. Into one end-opening should be fitted a frame with an upper and a lower groove, into which might be slid a "kit" or plate-carrier capable of holding an 8×10 inch plate, or the largest negative the operator is likely to use in reducing to slides. A

set of kits with openings for various sizes of negatives will make it possible to place the negative in one end of the box while excluding light from the remainder of the opening. This end of the box will go toward the window. If we look through the other end of the box, we shall be able to see, through transparent parts of the negative, when in position, the objects beyond the window, if any be in sight save the sky. One way to avoid this difficulty is to use a special table with long legs at one end and short legs at the other, or to "jack" up a wide board on the ordinary table-top, so that the range may bring the sky background. Another way is to work on the level and use a mirror or white surface ground glass beyond the negative. A mirror or white surface (such as a sheet of white cardboard) is placed in a frame outside the window at an angle of 45 degrees. The surface must be large enough to form a clear white background for the negative at the angle mentioned. The mirror gives the most brilliant and quickly illuminating background, since it simply reflects the sky through the negative and into the lens. If the sky is not clear, an intervening ground glass is necessary. The mirror or reflector is unnecessary, save for the increased illumination, if a piece of ground glass is hung or fitted against the window glass directly opposite the negative. The illumination in this case is naturally not so great as in the other.

In a skylight operating-room the copying camera is aimed at a slight angle downward, and a white angle reflector beyond the negative catches the light and furnishes the illumination to the plate.

The box being placed in position as suggested, a camera is placed behind it, with the lens toward the window. Whether the lens will require to be within the back rim of the box or still farther away, will depend upon the size of the negative which is to be copied and the angle of the lens in the camera used for copying. This may be determined at once by focusing. If the lens does not come within the line of the box, it will be particularly advisable to have a hood to fit from the rim of the box and fasten by a drawstring or elastic band to the neck of the lens. In any case such a hood is advisable.

The principle of the arrangement is this: that while a negative may be copied by simply setting it up in a window without excluding light in the space between the negative and the lens, the excluding of the light of the room gives the full strength of the negative image. Of course if the window admitted light at no point save through the negative, and light were admitted from no other window, special apparatus would be unnecessary.

The dry plates used for lantern slides are of thin "crystal" glass, packed much the same as

ordinary plates. They are slower than negative plates. To make good slides the best quality should be secured. A kit or holder must be used in placing the lantern plate in the camera-holder. As the glass is thinner than the glass of the plates for which kits are made, care should be taken that the lantern plate is forced to the surface of the holder, either by a spring or a piece of blackened cardboard of the same size fitted behind it.

Lantern plates may be developed with any developer; but as pyro tends to a yellow tinge, which, while sometimes beneficial to the negative, is undesirable if not ruinous to the slide, the pyro is generally excluded. I shall not offer any special formulas for slide developing here. Formulas come with the plates, and one or two are given in later pages of this book.

Do not make all lantern copies the same size; that is, for the same size opening. The mats sold for framing in the pictures give the largest possible opening, and are uniform; but there is no greater excuse for framing every lantern picture in the same way than there is for framing other pictures in a uniform manner. Each picture should be "centred:" that is, come precisely in the centre of the plate. To insure this, as well as to discover how large to make the copy, and how much may be included, paste one of the mats on the ground glass of the camera precisely at the point where the kit will bring the slide plate when it is in

position to be exposed. Agreeable variations on the round-cornered full opening are formed by squaring the lower part (lifting the lower frame line), and by forming small and large squares, circles, ovals, etc. But the simplest form of opening is generally the best for ordinary subjects.

The negative to be copied should face the copying camera, and by setting it upside down the image may be viewed right side up on the ground glass.

As blemishes in a lantern plate are greatly magnified on the screen, the plates should be carefully washed, fixed in a clear fixing bath, dried in a place free from dust, and otherwise finished with even greater care than a transparency, as already described.

The lantern plate is protected by a cover glass of the same size and thickness, held in place by a binding strip sold for the purpose. To guide the lantern operator, each slide should have a "thumb label" affixed to the left-hand lower corner.

ENLARGEMENTS.

Enlargements are generally made on bromide paper. The principle is simply that of "casting up" the image, as with a lantern, upon sensitive paper and then developing the image.

For making enlargements "solar cameras" and special apparatus are sold. I shall speak here only of enlarging with an ordinary camera.

A room for enlarging by the use of sunlight must be totally dark. A frame for holding the negative should be set into the window, light being excluded from all other parts of the window save a square of, say, 12 inches over the frame opening. In this upper opening should be fitted red glass or paper, and over it a rolling shade or a sliding shutter. This will enable the operator to examine the materials and adjust the paper by ruby light, and when this has been done the shade or shutter may exclude the red rays.

The camera may now be placed on a table in front of the frame opening, the lens pointed toward the negative, which is placed upside down in this grooved frame. A hood similar to that suggested in the remarks on lantern-slide making may be fitted over the negative frame in the window and around the neck of the lens, inclosing the space between. When the ground-glass back of the camera is lowered, the image will now be thrown upon any surface set to receive it, and the size will be governed by the nearness of the lens to the negative and the nearness of the reflecting surface.

If the camera has a forward focus, that is, a stationary bellows frame and a lens frame moved by a toothed wheel, another and better plan will be to turn the back of the camera to the window, blocking out the light with the hood or a close fitting frame.

The illustration (Fig. 20) shows the arrangement with a forward focus.

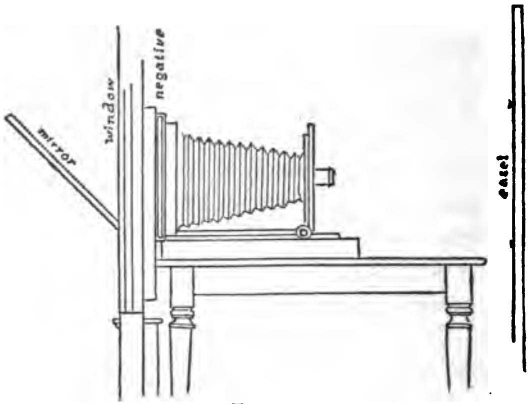


FIG. 20.

There are easels holding bromide paper in a large roll and provided with a frame for stretching the part of the sheet that is being exposed. If an improvised easel is used, it may be painted white or covered with white paper (pasted on, to avoid the chance of unevenness). The focusing may be done with this white surface, and the bromide paper then placed in position and held firmly by thumb tacks, strips of wood with elastic bands fastening at the back of the board, or other means of keeping the sheet flat. The placing of the paper must be accomplished by ruby light without moving the easel in the slightest degree; and if there is any doubt, the image may be scrutinized

on the bromide sheet at the time the exposure begins. In fact, this precaution is desirable in any case, it being quite possible to correct a blunder within the first two or three seconds of the exposure. No ruby light should be admitted during the exposure, as it would retard the action of the lens's rays.

The easel surface must be absolutely parallel with the negative, or the whole image will not be evenly in focus.

The general directions for developing bromide prints apply to bromide enlargements.

CHAPTER XVIII.

"MYSTERY" PICTURES.

CERTAIN mercantile photographers made something of a sensation a number of years ago by advertising "ghost" pictures. Much curiosity was excited by the production of pictures in which a person seated in a chair was accompanied by a pale image of a person who stood beside the chair, ghostlike, and through whose shadowy outlines the background of the room was visible.

The "mystery" of these pictures did not last very long for some people, but it lasted long enough for others to make it possible to practice deceptions as to "spirits." In fact, to this day such deception is continued.

The principle of the ghost picture is simply this: The sitter and the ghost, that is, another sitter, are placed in position and the plate is exposed for half the time necessary for a full exposure. The camera is capped, the "ghost" is removed, the lens is uncovered again, and the exposure completed, the "natural" sitter remaining perfectly still during the whole operation. The result is that the sitter is fully photographed,

while the "ghost" figure is but half photographed, giving the effect of an apparition.

Many curious and comic compositions can be produced on the same plan. Thus one person may be seated as if dreaming, while a number are photographed as ghosts of those of whom he or she is dreaming.

Another and more popular class of mystery pictures is that in which one person is photographed two or more times. Thus I have before me a picture called "Gentlemen of the Jury," in which a man in the attitude of counsel "summing up" is talking to a row of twelve men — all himself. Each face in the jury box has a different expression, though it is always that of the same person, and the effect is novel and amusing. Then, again, I have here a boy in the attitude of boxing with himself; a man playing chess with himself, and standing up at the back watching the game.

A description of the methods employed to accomplish these wonders is impossible here; but it may be said generally that a black or extremely non-actinic background is the basis of many of these curious things.

A simple "double" is produced in this way: The front of the camera is provided with a box extension having two doors in the front. These two doors must divide on a line precisely in the middle of the lens, so that when either door is open precisely half of the lens will operate.

The door of the front box may be held open, or the box removed during the focusing and "rehearsal." Thereafter a cloth may be thrown over the front of the camera in lieu of a lens cap, and to prevent the chance of light entering through any crack between the two doors.

The line of division in the picture being well understood, the subject is posed on one side of the line, then on the other, the corresponding door being opened for each exposure. A pneumatic exposer would do away with the necessity for the cover cloth. Out of doors the exposer will be almost indispensable for this sort of work.

Where the background is not very dark it is desirable that the line of division in the exposure should fall on some upright line, like the fold or division of a curtain or the frame of a door.

With an absolutely non-actinic background (like black in deep shadow) a figure may be photographed two or more times without the use of the mechanical device I have described. After returning the cap to the lens or releasing the shutter, the figure may be placed in any position that does not cross at any point the lines of the figure in the previous exposure. If the full figure is shown a floor covering of dark material will become necessary.

"Composite" portraits consist of an image produced by photographing a number of faces in precisely the same position. The different im-

pressions are sometimes taken on different plates and united in one print; by other methods they are made upon one negative.

To take all the impressions on one negative, the heads are posed at the same angle and at the same distance, so that the eyes fall on precisely the same line as drawn on the ground glass, and adjust themselves to a central vertical line. The exposure required for a complete impression is divided among all the heads to be photographed. In order that it may not be difficult to estimate very minute fractions and to make extremely short exposures, a small stop is used, say one requiring twenty seconds to secure a proper image. With such a stop, twenty faces may each be given one second exposure or ten people two seconds.

A method of making "magic pictures," discovered by Sir John Herschel, is as follows: A print on albumenized paper is fixed without toning, well washed, and soaked in a solution of perchloride of mercury until the image disappears. Again the paper is washed and dried. It now contains a latent, invisible image. To call it out once more in true magician fashion, soak a piece of blotting-paper in hyposulphite of soda. If the print be placed face downward upon this and brushed over with the hand, the image will start up and will be brighter than before its disappearance.

CHAPTER XIX.

SCIENCE, ART, AND THE CAMERA.

SCIENCE and the camera have been chums for a long time. To-day science would find it very difficult to think of getting along without photography. There is scarcely a department of scientific work that does not receive help from this handmaid, — the astronomer, the botanist, the chemist, the mining engineer, the physician, all have been assisted, sometimes in remarkable ways, by the lens and the sensitive plate.

Photography has made it possible to say, with an emphasis that was impossible before its coming, that we know the geography of the moon better than we do that of our own earth. The sun has been photographed in various moods, and the eclipses of Jupiter's satellites have been reported with a precision unknown before the days of the dry plate. The Paris Astronomical Congress in 1887 decided upon photographing the whole sky; and the great work, assigned to astronomical photographers throughout the world, is still in progress. I believe it is expected that over twenty thousand plates, ten inches square, will be required to tell the whole story of star-land.

To illustrate the immense value of photography in giving us pictures of the heavens, it is only necessary to remind the reader that the camera reports stars invisible to the eye through the finest telescope. This statement has a strange sound until we remember that the sensitive plate has a *cumulative* action; that is, it does not merely take notice of light at one time, but it stores up the effects of light rays until the cumulative action produces an image the momentary rays of which could not be perceived by the eye. The result of this fact has been to open up vast new fields to astronomy.

There is one great difficulty in photographing the heavenly bodies aside from that of the unsteadiness of the atmosphere, — the earth is moving and so are objects singled out by the lens. To overcome this obstacle, machinery has been constructed with such nicety that even for the long exposures which are occasionally necessary the telescope, lens, and sensitive plate steadily follow the moving object and leave not a blur upon the photographed image.

A telo-photographic lens recently invented is an interesting combination of telescope and lens. With this lens distant objects are brought wonderfully close, and the resulting image on the plate resembles that formerly produced by working telescope and camera-lens together.

Even in combination with the telescope, special

lenses are necessary for astronomical work. Since a lens of ten-inch focus will give an image of the moon only one tenth of an inch in diameter, it may be seen that one of fifty-inch focus would be necessary to give to the image a diameter of half an inch.

The amateur is more likely to effect a partnership between the camera and the microscope than between the camera and the telescope. The results of such a partnership are extremely interesting, and it is not difficult to understand why photo-micrography or photo-microscopy should have become a popular as well as a scientifically important department of photography.

A simple method of uniting the camera and microscope is to place the camera on a table in the ordinary position with the lens removed. The microscope is placed in a horizontal position, the eyepiece entering the camera and acting in place of the lens. A lamp and condenser may be placed behind the microscope, and the space between the two instruments covered with a focusing cloth.

In this class of work accurate focusing is, naturally, of great importance, and a focusing glass or other magnifier should be used in studying the ground-glass image. Difficulty may arise, too, from the fact that the glasses of the microscope are seldom corrected for the actinic rays, and only experiment can make allowance for this peculiarity.

By removing the eyepiece of the microscope, and, if possible, shortening the tube, the field is made wider. Properly the interior of the tube should be blackened or lined with black velvet, so that it shall have no glitter or shine.

For careful scientific work a special extension camera is used. This is a long bellows in two removable sections, and with a front board permitting a satisfactory union with the microscope.

The rude apparatus for making lantern slides may be turned into a sort of low-power microscopic medium, if the camera has a sufficiently long bellows. By placing the camera lens close to an object and drawing out the bellows, an enlarged image may be procured. This, in turn, may be enlarged and give a greatly magnified image of the original object.

"Micro-photographs" is the name given to minute photographs, some of the smallest of which have been placed behind minute magnifying glasses in fancy articles. The term "microphotography" is sometimes used by mistake for photo-micrography.

The copying of pictures, maps, or other objects of the kind, is a simple but exacting process; for unless the work is done accurately, it loses its value. A picture to be copied must be placed so that it has upon it a full light, evenly distributed over the surface. In working under a skylight the picture is tilted so that the light may fall

evenly. The camera must be given precisely the same angle of the picture surface. If the picture is an oil painting, and has a surface that glistens at certain angles of light, care must be taken to place it in a position that prevents this glistening. Study it from the point of view of the lens, and watch in the focusing for unevenness in the lighting. A small stop should be used during the final exposure.

Copies of maps or line drawings should be developed with a developer that gives strong blacks in the negative, rather than with one that gives softness or delicacy. Thus, either pyro, hydrochinon, or any of the more brilliant of the later developers will be better than iron.

I have suggested that there are a multitude of ways in which photography has aided science. There are many ways, also, in which photography has aided art. The human eye is easily deceived. If it helps to teach the mind, the mind has much to teach the eye. When we know where to look for things, we begin to see them. When we learn, by other means than through the eye, about the actual forms, colors, and qualities of things, the eye begins to notice more particularly these forms, colors, and qualities. Thus we find artists studying muscles and their action, in order that they may not only be able to draw the human figure itself, but the clothed figure in which it might be thought that the muscles were so far

IN ST. AUGUSTINE

Showing Photograph treated with India ink wash for illustration

Plate by Electro-Light Engraving Co., New York

hidden that there could be no necessity for knowing very definitely about them. The truth is, that we do not see accurately where muscles *are*, until we know where they *should be*. It is this fact that underlies all the study of art.

The eye, then, is a mere window for the reason behind it. A good illustration of the carelessness of the eye is furnished by any of the older pictures of lightning. You have seen lightning flashes in old paintings and prints, — a series of straight lines, broken here and there. When the camera came to report the lightning, we saw that the flashes were like rivers of light, produced by the traveling of the electrical sparks, with a multitude of tributary rivers of fire, and nowhere the slightest resemblance to a straight or even approximately straight line. Yet, while lightning has always been the same, men went on, century after century, looking at lightning and representing it in the straight lines with which we are so familiar. It is now quite easy for us to see, *when we know better*, that the sparks of lightning run in lines that the eye may only see in rivers of fire.

In fact, the history of art shows that before men get to looking at things intelligently, and actually knowing about them, they *represent* them. When knowledge comes, — sometimes through the eyes of some one who sees better than others, sometimes through the experiments

of some one who *thinks* better than others, men learn to *imitate* things and to secure something like a truthful likeness.

We see this again in animal locomotion. Before the coming of instantaneous photography, people had curiously careless methods of representing the movements of the horse. They *represented* the horse's movements in a general way. To a certain extent, motion can never be more than represented in a picture. But the point is, that when the camera gave its report, we began to look at motion more carefully, to see more and better; and to-day, although artists do not yet agree to represent locomotion as it actually appears at any one movement, — holding that a picture should combine the impression of more than one movement,— there can no longer be the old-fashioned errors in the alternation of the feet or in the general position of the legs of the horse. A picture of a horse with all four legs widely extended seems like a card-board charger, and we feel like looking for the string that holds him up.

The artist's reason for not drawing the moving horse as the camera does is that "arrested motion" does not look like real motion, and that, since the eye does not see one phase of a movement at a time, there must be a compromise. It is true that the eye cannot single out a brief phase of a movement, because any impression that strikes the retina of the eye, lingers there for

about the seventh part of a second. Thus one impression overlaps another, and we cannot separate the different parts of the series.

But we must remember that the eye has learned many truths about motion since the camera lent its aid, and when we *know* how a horse gallops, we can no longer seem to see it gallop as we once did.

If knowledge is so important to the work of the eye, we can see that anything which increases the artist's knowledge of things is an aid to art.

Since art is not merely the imitation of nature, but an artist's ideas about nature, the better the artist's *knowledge* about facts, the more valuable will be his *ideas* about facts.

It is because art is not the imitation of nature that we cannot call photography an art. Photography, of itself, gives us only a reflection of nature. This reflection is not art, but only more nature — nature repeated as it might be in a mirror. But if photography is of itself a science, it may be made the medium of expressing artistic ideas, as every reader of this book will doubtless seek to prove. Indeed, photography has made it very difficult at times to say where science leaves off and art begins.

CHAPTER XX.

"BIRDS OF A FEATHER."

PHOTOGRAPHY is a sociable kind of enthusiasm, and there is nothing surprising in the fact that photographic clubs should have come to be so popular. The average person, young or old, would rather not "flock all by himself" unless there was no way out of it. In photography the grumblers need a sympathetic ear into which they can pour tales about wicked camera-makers, inferior plates, and bad weather; and a success has twice its ordinary charm when it may be pictured to an admiring company. There are a score of reasons why people with cameras should establish themselves in groups, and so in good time came the photographic club.

At first the photographic club meant simply a coterie of camera people who assembled now at this house, now at that, to discuss means, compare results, and "swap" formulas. These house gatherings, still very popular, long afforded an excellent means of communication between people devoted to the camera hobby. But by and by the need for permanent quarters with some kind

of an equipment brought about the formation of definitely located clubs — clubs with "quarters" more or less ample, generally less, of course, at the beginning.

These clubrooms became the centre of various interesting photographic movements. If the growing popularity of photography increased the number and size of these societies, the societies, in turn, naturally became one of the chief means of popularizing photography.

To-day amateur photographic societies are scattered over the whole world. In every civilized country they are found fitting up dens and meeting-rooms. Japan and even conservative old China have not been able to resist the fascinations of the lens and dry plate. And between all these groups, in New York and in Chicago, in London and in Vienna, in Melbourne and in Tokio, a kind of freemasonry has sprung up — a freemasonry rich in secrets that everybody is ready and eager to tell. Through the medium of a thousand and one periodicals and pamphlets these societies hear a good deal of each other. In some of the journals complete stenographic reports of society meetings have been duly unfolded, so that when an amateur sneezes at a meeting in New York the amateur in Boston is presented with an accurate record of the episode; and any little spat over a newly discovered developing formula is passed down to history without a hair's breadth of mitigation.

And then these societies communicate directly with each other by the medium of exchange. Of late years some interesting movements on the exchange plan have been successfully undertaken. If I am not mistaken, a Boston society started off with a group of lantern-slide pictures illustrating "Picturesque Boston," which was forwarded for display before different societies of a similar kind in different States. Other cities have reciprocated; San Francisco has sent to the East spirited "Glimpses of California," and the pleasant result of photographic enthusiasm has become an interesting feature of life among the clubs. Accompanying each of these groups of pictures, fully prepared for projection with the stereopticon, is a written lecture or talk, with a detailed list showing the sequence of the pictures.

The exchange of miscellaneous lantern pictures long ago justified the forming of a regularly organized Lantern Slide Interchange, and the pictures have not only passed from State to State, but are crossing the Atlantic in exchange with European clubs.

In fact, the ease with which a photographic negative may be converted into a lantern positive and projected upon a screen before an audience, has given amateur societies their chief source of entertainment and profit. The member who has carried his camera through Europe is made to stand and deliver on his return, and entertains a gather-

ing in the club rooms with a photographic record of his journey.

Perhaps it has been the delight of telling adventurous stories and showing adventure-telling pictures that has led amateurs to enter dangerous paths in search of the picturesque. Both photographer and camera have sometimes toppled over precipices; but happily photography is not, taken altogether, a very dangerous pursuit. Most picture-makers are willing, if they are not compelled, to confine themselves to familiar and even commonplace themes. A few may wish they could get into the Congo jungles and "snap" a lion or two; but the majority are wisely willing to take their photography with the danger left out.

The ambitious amateur is restrained, too, by the fact that so much that is done out of doors is done in groups. The club makes photographic excursions. It settles upon a plan of action and then swoops down upon beach, river, or country-side in full force, bristling with cameras, working sometimes with the precision of an army, but oftener with the erratic movements of a skirmish line.

These photographic excursions have their adventures in a small way: if it does not always rain, it very often tries to do so; boats and trains stop running when they are not expected to do anything of the kind; parks are closed, restaurants are barren of supplies, and roads are not always what

they have been claimed to be. Of course the right-minded member always sees additional fun in these situations. The unexpected that is always happening is as picturesque as the things mentioned in the programme. The hungriest member in the midst of his inquiries is a capital subject for a picture. And the fellow who is always saying, — or who, by the expression of his face, is at least plainly thinking, — Who proposed this trip, anyhow? should always be caught by the "detective" member in the midst of his denunciations. In fact, on the average trip the club itself is the best subject. It has plenty of variety. It never looks twice the same way.

Considerable coöperative work of a serious kind has recently been accomplished by photographic societies. It has become the excellent fashion for clubs to make organized reports of historical events. Public celebrations are photographed in great detail from every point of view, so that future generations will find little left to tax the imagination. It is grimly said that our descendants will know beyond dispute whether the great men of this era (not to mention the "small fry") turned their toes in or out when they walked.

It might be interesting to offer here some hints to those who may be inclined to organize photographic clubs; but this would be made very difficult by the fact that the arrangement of a club

and its quarters must depend entirely upon the number of the people who are to compose it and the local conditions.

I find among my photographic papers this title and statement of principles, adopted by a certain society: —

Sun and Company.

Limited to 30 Amateur Photographers.

For the circulation and criticism of photographs entirely the work of members, and for a general interchange of ideas, with a view to mutual advancement in the science and art of photography.

A club may begin with a general aim of this kind, and when its numbers are sufficient it may find rooms and undertake as much in the way of dark-rooms and apparatus as its resources may permit. Few amateurs are able to own copying, enlarging, or projecting outfits; yet the coöperation of even a comparatively few people will make it possible to own these outfits without great expense, for the ownership need not imply the hiring of rooms, though there are many obstacles to a "house to house" ownership.

A club dark-room should have accommodations for at least two workers. There should be rigid rules as to care and cleanliness. "Lockers" may be devised for storing the materials and utensils of individual members. The general meeting room may have the double use of an operating

room or portrait gallery in the daytime and an assembly or exhibition room at night.

It need scarcely be said that the social side of a photographic club is an agreeable feature of its character, but the social spirit should not obscure the serious purposes of the organization.

APPENDIX.

NOTES ON THE CHEMISTRY OF PHOTOGRAPHY.

Light itself is a chemical agent having the power to produce both combination and decomposition. Professor Meldola groups these instances of the action of light: Chlorine water under the influence of light gradually becomes acid from the formation of hydrochloric acid, whilst oxygen is liberated. An aqueous solution of hydriodic acid is gradually decomposed by light and becomes brown from the liberation of iodine. In the latter instance light is actually an accelerator, as the same decomposition will go on in the dark. An ethereal or alcoholic solution of ferric chloride is reduced by light. Uranic salts in contact with organic substances, such as alcohol, ether, glycerol, paper, etc., behave like the ferric compounds and undergo reduction on exposure to light. Important processes are based on the fact that light not only reduces chromatized gelatine, but renders the gelatine insoluble.

. . . The action of light on silver salts has been sketched early in this volume. In certain conditions silver does not show change except when in the presence of organic matter. Thus the nitrate of silver solution used in silvering paper remains perfectly clear and

transparent in the jar, even when exposed to full sunlight. But the moment this fluid touches the finger or a sheet of paper, light begins to turn it brown.

. . . The chemical changes which produce a finished negative are, progressively, the change produced by light, the further change produced by development, and the final change produced by the "hypo" or thiosulphate. The rapidity of a plate depends, not merely upon the preparation of the film, but upon the nature of the developer in combination with the elements of the "sensitizer" on the film.

. . . By "Draper's law" it appears that only the rays of light that are absorbed by the sensitized surface produce any effect. But Dr. Vogel has explained that by the use of more than one element, as by the addition of iodide to bromide, more than one sort of light rays is absorbed. It is by the following out of this hint that orthochromatic, or so-called "color-sensitive," plates are being produced. An excessive absorption or an excessive action in the developer destroys the possibility of a perfect image.

. . . In the wet-plate process silver nitrate is reduced by substances which may produce oxidation, the image growing by a deposit of silver upon that already on the film. For this process an *acid developer* is necessary. In the dry-plate process an *alkaline developer* is used to reduce the photo-salt to metallic silver. A wet plate with silver nitrate present as a sensitizer would be ruined by an alkaline developer. The gelatine emulsion dry plate having no free silver nitrate, a strong developer may be used; and by the combination of the more sensitive surface and the stronger developer, instantaneous photography becomes possible.

. . . "Orthochromatic" plates or "color-sensitive" plates, so called, are prepared with a view to overcoming the deficiency of ordinary plates in the treatment of the non-actinic or comparatively non-actinic colors. Dr. Vogel tinted collodion films with coal-tar dyes and discovered that the films were thereby rendered more sensitive to yellow and greenish yellow. Gelatine emulsion plates are now treated with coloring matter, sometimes in the setting of the emulsion itself, sometimes by subsequent immersion. By means of plates treated in this way a material advance has been made in the interpretation of natural colors. Doubtless in due time all plates used in photography will be so treated.

. . . Pure water is less important in some phases of photographic work than in others, but it is always desirable. Distilled water is the ideal. A distilling apparatus is easily procured, distillation simply being the gathering of condensed steam. Filtered rain water is the next best thing to distilled water. Melted snow is regarded as desirable for its purity. River water of the better kind is safer than well water.

. . . To test the acidity or alkalinity of a solution, strips of paper stained with litmus are used. These should be kept in an air-tight bottle. The paper is made in two colors — an acid solution turning the blue paper red, and an alkaline solution turning the red paper blue.

. . . A solution of a substance containing all of the substance that will remain in solution and not deposit is called a "saturated solution." Some substances dissolve quickly; others will not dissolve readily without long shaking or the use of boiling water. In cold

weather there will be a precipitation in certain solutions, as temperature has a good deal to do with the quantity of a substance that water will hold in solution. For this reason it is well to have the dark-room free from extremes of temperature. In "stock solutions" an excess of a substance that settles in the bottom of the bottle may be left in the bottle. The subsequent addition of water will take up the remainder. Any druggist will explain how to use filtering paper.

... The drops of different fluids vary in size, a fact which must be remembered in following certain chemical prescriptions. Dr. Eder, in the following table, gives the number of drops required to make a cubic centimeter, which equals 17 minims :

Water	20	Castor oil	44
Hydrochloric acid	20	Olive oil	47
Nitric acid	27	Oil of turpentine	55
Sulphuric acid	28	Alcohol	62
Acetic acid	38	Ether	83

PHOTOGRAPHY IN COLORS.

Immense labor has been expended in recent years on efforts to secure photographs in the colors of nature.

At present the nearest approach to a photograph in colors seems to be the image produced by the making of three different negatives through violet, red, and green color screens, these products being superimposed in the final image. Accurate and beautiful images in color have thus been produced by Mr. Ives of Philadelphia, who has patented an instrument, designed to accomplish this sort of combination photography, called the Helidromscope.

TABLE OF THE ELEMENTS:

THEIR SYMBOLS, ATOMIC WEIGHTS, AND EQUIVALENTS.

Compiled by A. H. Elliott, Ph. D., from Watts' "Dictionary of Chemistry," 1888.

	Symbol.	Atomic Weight.	Equivalent.		Symbol.	Atomic Weight.	Equivalent.
Aluminium .	Al	27.02	9.007	Mercury....	Hg	199.8	99.9
Antimony...	Sb	120.	40.	Molybdenum	Mo	95.8	19.16
Arsenic.....	As	74.9	24.97	Nickel......	Ni	58.6	29.3
Barium.....	Ba	136.8	68.4	Niobium....	Nb	94.	31.33
Beryllium ..	Be	9.08	4.54	Nitrogen....	N	14.01	4.67
Bismuth....	Bi	208.	69.33	Osmium	Os	193.	24.125
Boron	B	10.09	3.66	Oxygen.....	O	15.96	7.98
Bromine....	Br	79.75	79.75	Palladium ..	Pd	106.2	26.55
Cadmium...	Cd	112.	56.	Phosphorus.	P	30.96	10.32
Cæsium.....	Cs	133.	132.7	Platinum ...	Pt	194.3	48.575
Calcium	Ca	39.9	19.95	Potassium ..	K	39.04	39.04
Carbon	C	11.97	2.99	Rhodium ...	Ro	104.	26.
Cerium.....	Ce	139.9	46.6	Rubidium...	Rb	85.2	85.2
Chlorine....	Cl	35.37	35.37	Ruthenium	Ru	104.4	26.1
Chromium..	Cr	52.4	26.2	Selenium ...	Se	78.8	39.4
Cobalt......	Co	59.	29.5	Silicon......	Si	28.3	7.
Copper	Cu	63.2	31.6	Silver.......	Ag	107.66	107.66
Didymium ..	Di	143.0	47.8	Sodium.....	Na	23.	23.
Erbium.....	E	165.9	55.3	Strontium ..	Sr	87.3	43.65
Fluorine....	F	19.1	19.1	Sulphur	S	31.98	15.99
Gallium	Ga	69.	23.	Tantalum. ..	Ta	182.	60.67
Gold	Au	197.	65.66	Tellurium ..	Te	125.	62.5
Hydrogen...	H	1.	1.	Thallium ...	Tl	203.64	203.64
Indium.....	In	113.4	37.8	Thorium....	Th	231.87	57.97
Iodine......	I	126.53	126.53	Tin.........	Sn	117.8	58.9
Iridium.....	Ir	192.5	48.125	Titanium ...	Ti	48.0	12.
Iron........	Fe	55.9	27.95	Tungsten ...	W	183.6	30.6
Lanthanum.	La	138.5	46.17	Uranium....	U	240.	60.
Lead	Pb	206.4	103.2	Vanadium ..	V	51.2	17.07
Lithium	Li	7.01	7.01	Yttrium	Y	89.6	29.87
Magnesium .	Mg	24.	12.	Zinc........	Zn	65.2	32.6
Manganese..	Mn	55.	27.5	Zirconium..	Zr	90.	45.

NOTE. — The equivalent numbers are the smallest quantities of the element that unite with one part of hydrogen, eight parts of oxygen, or thirty-five parts of chlorine.

ENGLISH WEIGHTS AND MEASURES.

It is a great misfortune that there should be so much confusion as to weights and measures. While all chemicals are usually sold by avoirdupois weight, formulas are usually written in apothecaries' weight. The advantage of a general adoption of the French metric system has frequently been suggested.

APOTHECARIES' WEIGHT.

(USED IN FORMULAS.)

SOLID MEASURE.

20 grains	=	1 scruple	=	20 grains.
3 scruples	=	1 dram	=	60 grains.
8 drams	=	1 ounce	=	480 grains.
12 ounces	=	1 pound	=	5760 grains.

FLUID.

60 minims	=	1 fluid dram.
8 drams	=	1 ounce.
20 ounces	=	1 pint.
8 pints	=	1 gallon.

AVOIRDUPOIS WEIGHT.

(USED IN THE SALE OF CHEMICALS.)

$27\frac{11}{32}$ grains	=	1 dram	=	$27\frac{11}{32}$ grains.
16 drams	=	1 ounce	=	$437\frac{1}{2}$ grains.
16 ounces	=	1 pound	=	7000 grains.

TROY WEIGHT.

(USED IN THE SALE OF PRECIOUS METALS.)

24 grains	=	1 pennyweight	=	24 grains.
20 pennyweights	=	1 ounce	=	480 grains.
12 ounces	=	1 pound	=	5760 grains.

FRENCH WEIGHTS AND MEASURES

AND THEIR EQUIVALENTS IN ENGLISH.

1 cubic centimetre	=	17 minims (nearly).
3½ " "	=	1 dram.
28.4 " "	=	1 ounce.
100 " "	=	3 ounces 4 drams 9 minims.
50 " "	=	1 ounce 6 drams 5 minims.
1000 " " or 1 litre, = to 61 cubic inches	=	35 ounces 1 dram 36 minims.

The unit of French liquid measure is the cubic centimetre, measuring nearly 17 minims, and weighing 15.4 grains or 1 gramme. The unit of French weights is the gramme, equal to 15.4 grains.

STEREOSCOPIC PHOTOGRAPHY.

To make stereoscopic photographs a camera fitted with matched lenses is required. The lenses are generally mounted three and a half inches apart, and for instantaneous views the exposures are necessarily simultaneous, and should be approximately so in any case. The images are transposed when mounted.

ELSDEN'S TABLE OF POISONS AND ANTIDOTES.

	Poisons.	Remarks.	Characteristic Symptoms.	Antidotes.
Vegetable Acids.	OXALIC ACID, including POTASSIUM OXALATE	1 drachm is the smallest fatal dose known.	Hot burning sensation in throat and stomach; vomiting, cramps and numbness.	Chalk, whiting, or magnesia suspended in water. Plaster or mortar can be used in emergency.
Caustic Alkalies.	AMMONIA, POTASH, SODA	Vapor of ammonia may cause inflammation of the lungs.	Swelling of tongue, mouth, and fauces; often followed by stricture of the œsophagus.	Vinegar and water.
Metallic Salts.	MERCURIC CHLORIDE	3 grains the smallest known fatal dose.	Acrid, metallic taste, constriction and burning in throat and stomach, followed by nausea and vomiting.	White and yolk of raw eggs with milk. In emergency, flour paste may be used.
	ACETATE OF LEAD	The Sub-acetate is still more poisonous.	Constriction in the throat and at pit of stomach; crampy pains and stiffness of abdomen; blue line round the gums.	Sulphates of soda or magnesia. Emetic of sulphate of zinc.
	CYANIDE OF POTASSIUM	*a.* Taken internally, 3 grains fatal.	Insensibility, slow gasping respiration, dilated pupils, and spasmodic closure of jaws.	No certain remedy; cold affusions over the head and neck most efficacious.
		b. Applied to wounds and abrasures of the skin.	Smarting sensation.	Sulphate of iron should be applied immediately.
	BICHROMATE OF POTASSIUM	*a.* Taken internally.	Irritant pain in stomach, and vomiting.	Emetics and magnesia, or chalk.
		b. Applied to slight abrasions of the skin.	Produces troublesome sores and ulcers.	
	NITRATE OF SILVER		Powerful irritant.	Common salt to be given immediately, followed by emetics.
Concentrated Mineral Acids.	NITRIC ACID	2 drachms have been fatal. Inhalation of the fumes has also been fatal.	Corrosion of windpipe, and violent inflammation.	Bicarbonate of soda, or carbonate of magnesia or chalk; plaster of the apartment beaten up in water.
	HYDROCHLORIC ACID	½ ounce has caused death.		
	SULPHURIC ACID	1 drachm has been fatal.		
	ACETIC ACID, concentrated, has as powerful an effect as the mineral acids.			
	IODINE	Variable in its action; 3 grains have been fatal.	Acrid taste, tightness about the throat, vomiting.	Vomiting should be encouraged, and gruel, arrow-root, and starch given freely.
	ETHER	When inhaled.	Effects similar to chloroform.	Cold affusion and artificial respiration.
	PYROGALLOL	2 grains sufficient to kill a dog.	Resembles phosphorus poisoning.	No certain remedy. Speedy emetic desirable.

FORMULAS FOR DEVELOPING DRY PLATES.

WITH PYROGALLOL.

CARBUTT'S

No. 1.

Distilled or ice water	10 ounces.
Sulphuric acid	1 dram.
Sulphite of soda crystals	4 ounces.

Add Schering pyro 1 ounce, and water to make 16 fluid ounces.

No. 2.

Water	10 ounces.
Soda sulphite crystals	2 ounces.
Soda carbonate crystals	2 ounces (or dry gran. 1 oz.).
Potash carbonate	1 ounce.

Dissolve, and add water to make measure 16 fluid ounces.

No. 3.

Bromide of sodium or potassium, ½ ounce. Water, 5 ounces.

Developer.— Dilute 1 ounce of No. 2 with 7 ounces of water for cold weather, and 10 to 12 of water in summer. To 3 ounces of dilute No. 2 add 1½ drams of No. 1. The more pyro the denser the negative, and *vice versa.*

EASTMAN'S.

Pyrogallol Solution.

Pyrogallic acid	½ ounce.
Nitrous or sulphuric acid	20 minims.
Water	32 ounces.

Ammonia Solution.

Ammonia, stronger (900)	1 ounce.
Bromide of potassium	1 dram.
Water	32 ounces.

Soda Solution.

Carbonate of soda (crystals)	4 ounces.
Sulphite of soda "	4 ounces.
Water	32 ounces.

Potash Solution.

Carbonate of potash	3 ounces.
Sulphite of soda	4 ounces.
Water	32 ounces.

For the ammonia developer use ½ ounce each of pyro and ammonia solutions and 3 ounces of water.

For the soda developer, use 1 ounce each of pyro and soda solutions and 2 ounces of water.

For the potash developer, use 1 ounce each of the pyro and potash solutions and 2 ounces of water.

For the potash and soda developer, use ½ ounce each of soda and potash solutions, 1 ounce pyro solution, and 2 ounces of water.

Restrainer For Over-exposure.

Bromide of potassium	1 ounce.
Water	6 ounces.

A few drops to be used for over-exposure only.

CRAMER'S

Alkali Solution.

Water	60 ounces.
Carbonate of soda (crystals)	5 ounces.
Sulphite of soda "	10 ounces.

Pyro Solution.

Distilled or pure ice water	6 ounces.
Sulphuric acid	15 minims.
Sulphite of soda (crystals)	1 dram.
Pyrogallic acid	1 ounce.

Eight grains of dry pyro may be substituted for 1 dram of this solution.

Mix in the following proportions: —

Pyro solution	1 dram.
Alkaline solution	1 ounce.
(In winter) Tepid water	2 ounces.
(In summer) Cold water	3 to 5 ounces.

WITH EIKONOGEN.

HARVARD.

No. 1.

Sulphite of soda	3 ounces.
Sulphuric acid	$\frac{1}{4}$ ounce.
Eikonogen	1 to $1\frac{1}{2}$ ounces.
Water	60 ounces.

No. 2.

Carbonate of soda	1 ounce.
Water	24 ounces.

Use (3) parts of No. 1, one part of No. 2. The mixture may be used repeatedly. For under-exposed negatives dilute, using freshly united No. 1, and No. 2.

WITH PARAMIDOPHENOL.

STANLEY'S.

Rodinal	$\frac{1}{2}$ ounce.
Sulphite of soda, 40 hydrometer test	2 ounces.
Water	14 ounces.

Developer. Use full strength.

SEED'S.

No. 1.

Paramidophenol	$\frac{1}{2}$ ounce.
Ferrocyanide of potassium	$3\frac{1}{2}$ ounces.
Sulphite of sodium	$4\frac{3}{4}$ ounces.
Water	75 ounces.

Developer. Equal parts of each.

WITH HYDROCHINON (FOR LANTERN SLIDES).

HART'S FORMULA.

Water	4 ounces.
Sulphate of soda	2 drams.
Carbonate of soda	2 drams.
Phosphate of soda	80 grains.
Hydrochinon	25 grains.

EXPLANATION OF CERTAIN PHOTOGRAPHIC TERMS.

Achromatic. A term applied to lenses that have been so treated that the images they form are free from rims or fringes of color. A lens not free from this photographic defect is said to have *chromatic aberration.*

Aplanatic. Applied to lenses that have been treated for both spherical and chromatic aberration.

Depth of focus. A lens is said to have great depth of focus when it gives clear images of objects at widely different distances from the lens.

Equivalent focus. This term is generally used to describe the distance between the diaphragm slot in a doublet lens and the focusing screen or ground glass when the lens has been focused on distant objects.

Halation. The radiation of the high lights in a negative beyond the line of adjoining shadows. It is caused by reflection in the glass plate and from certain chemical conditions, but is very largely remedied by "backing" the plate with some dark-colored substance, such as a mixture of powdered burnt sienna, gum, glycerine and water. On films there is very little halation, a fact explained by the circumstance that they are backed by an opaque surface.

Macro-photography. The production of enlarged photographs.

Measles. A spotty defect in prints due to imperfect fixing.

Micro-photography. The production of minute photographs.

Photo-micrography. The photographing of microscopic objects.

Restrainer. Any ingredient used to retard the action of a developer. Anything used for the opposite purpose is an *accelerator.*

Retouching. Inaccurate term used to describe the treatment of the image with pencil or brush to remove blemishes, or modify the effect.

Solar camera. A camera used for enlarging by daylight.

Varnishing. Method used to preserve the surface of the negative and as a basis for "retouching" treatment. The negative is first warmed; the varnish is then poured on, the plate being held by one corner in a flat position in the left hand. By slightly tilting the plate the varnish soon covers the surface and is drained off at one corner. This should be practiced on a spoiled negative, for considerable dexterity is required to insure against ruining the negative.

TABLE FOR ENLARGEMENTS.

From the British Journal of Photography Almanac.

Focus of Lens, inches.	TIMES OF ENLARGEMENT AND REDUCTION.							
	1 in.	2 in.	3 in.	4 in.	5 in.	6 in.	7 in.	8 in.
2	4 4	6 3	8 2 2/3	10 2 1/2	12 2 2/5	14 2 1/3	16 2 2/7	18 2 1/4
2 1/2	5 5	7 1/2 3 3/4	10 3 1/3	12 1/2 3 1/8	15 3	17 1/2 2 11/12	20 2 6/7	22 1/2 2 13/16
3	6 6	9 4 1/2	12 4	15 3 3/4	18 3 3/5	21 3 1/2	24 3 3/7	27 3 3/8
3 1/2	7 7	10 1/2 5 1/4	14 4 2/3	17 1/2 4 3/4	21 4 1/5	24 1/2 4 1/12	28 4	31 1/2 3 15/16
4	8 8	12 6	16 5 1/3	20 5	24 5 4/5	28 4 2/3	32 4 4/7	36 4 1/2
4 1/2	9 9	13 1/2 6 3/4	18 6	22 1/2 5 5/8	27 5 2/5	31 1/2 5 1/4	36 5 1/7	40 1/2 5 1/16
5	10 10	15 7 1/2	20 6 2/3	25 6 1/4	30 6	35 5 5/6	40 5 5/7	45 5 5/8
5 1/2	11 11	16 1/2 8 1/4	22 8 1/8	27 1/2 6 7/8	33 6 1/2	38 1/2 6 5/12	44 6 2/7	49 1/2 6 3/16
6	12 12	18 9	24 8	30 7 1/2	36 7 1/5	42 7	48 6 6/7	54 6 3/4
7	14 14	21 10 1/2	28 9 1/3	35 8 3/4	42 8 2/5	49 8 1/6	56 8	63 7 7/8
8	16 16	24 12	32 10 2/3	40 10	48 9 3/5	56 9 1/3	64 9 1/7	72 9
9	18 18	27 13 1/2	36 12	45 11 1/4	54 10 4/5	63 10 1/2	72 10 2/7	81 10 1/8

The object of this table is to enable any manipulator who is about to enlarge (or reduce) a copy any given number of times, to do so without troublesome calculation. It is assumed that the photographer knows exactly what the focus of his lens is, and that he is able to measure accurately from its optical centre. The use of the table will be seen from the following illustration: A photographer has a *carte* to enlarge to four times its size, and the lens he intends employing is one of six inches equivalent focus. He must, therefore, look for 4 on the upper horizontal line, and for 6 in the first vertical column, and carry his eye to where these two join, which will be at 30 — 7 1/2. The greater of these is the distance the sensitive plate must be from the centre of the lens; and the lesser, the distance of the picture to be copied. To *reduce* a picture any given number of times the same method must be followed, but in this case the greater number will represent the distance between the lens and the picture to be copied; the latter, that between the lens and the sensitive plate. This explanation will be sufficient for every case of enlargement or reduction.

If the focus of the lens be twelve inches, as this number is not in the column of focal lengths, look out for 6 in this column and multiply by 2, and so on with any other numbers.

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